Circuit Description

Isolated Power Supply
AC line power comes into the board from the servo board. A fuse (FU1) protects transformer T1.

The secondary AC voltages from T1 are rectified (BR1) and filtered (C1) to provide voltages for the optical couplers and the film charger relay.

Hand Start Circuit
The hand start switch controls optical isolators U5 and U2. The other side of the isolator feeds inverters (U11D and U11E) to provide start commands to the analog interface board. These commands change their logic state when the hand start switch is closed and opened. These remote start commands are received on the analog interface board (U27A) and sent to the processor board (U25).

Inhibit Circuit
An external switch can be used to inhibit the start function of the injector. With the switch open, relays K1 and K2 are energized, allowing the injector to start. Closing the inhibit switch turns on opto-isolator U1, which will turn Q4 off. With Q4, relay K1 and K2 are de-energized which prohibits injector start signal from being received by analog board.

Film Changer Control Circuit
The film changer signal from the processor board is inverted and drives one side of an optical isolator (U8).

When activated, the other side of the isolator turns on a relay driver (Q1) to energize the coil of the film charger relay. The relay's normally-open contacts are connected through J4 to an external device.

Enabled Signal Circuit
The enabled signal from the analog interface board drives opto-isolator U4 which drives transistors Q4 and Q3 to energize a normally-open relay (K3). When the ENABLED light is on, this relay is closed to provide a signal to the circuit connected to Universal Interface Connector.

Injecting Signal/Handswitch/Sync Output
The mode of operation is selected using slide switch SW1. In the *normal* mode, when the INJECTING light is illuminated, the output relay (K4) is on. In the *handswitch* mode, the output relay (K4) will turn on anytime the handswitch is closed.

Fail Mode
If either remote start or start input opto-isolators fail, timer (U9) will delay for 100 ms and then turn off Q4, which turns off K1 and K2 to inhibit the injector start signals. Power must be removed to reset this fail mode.

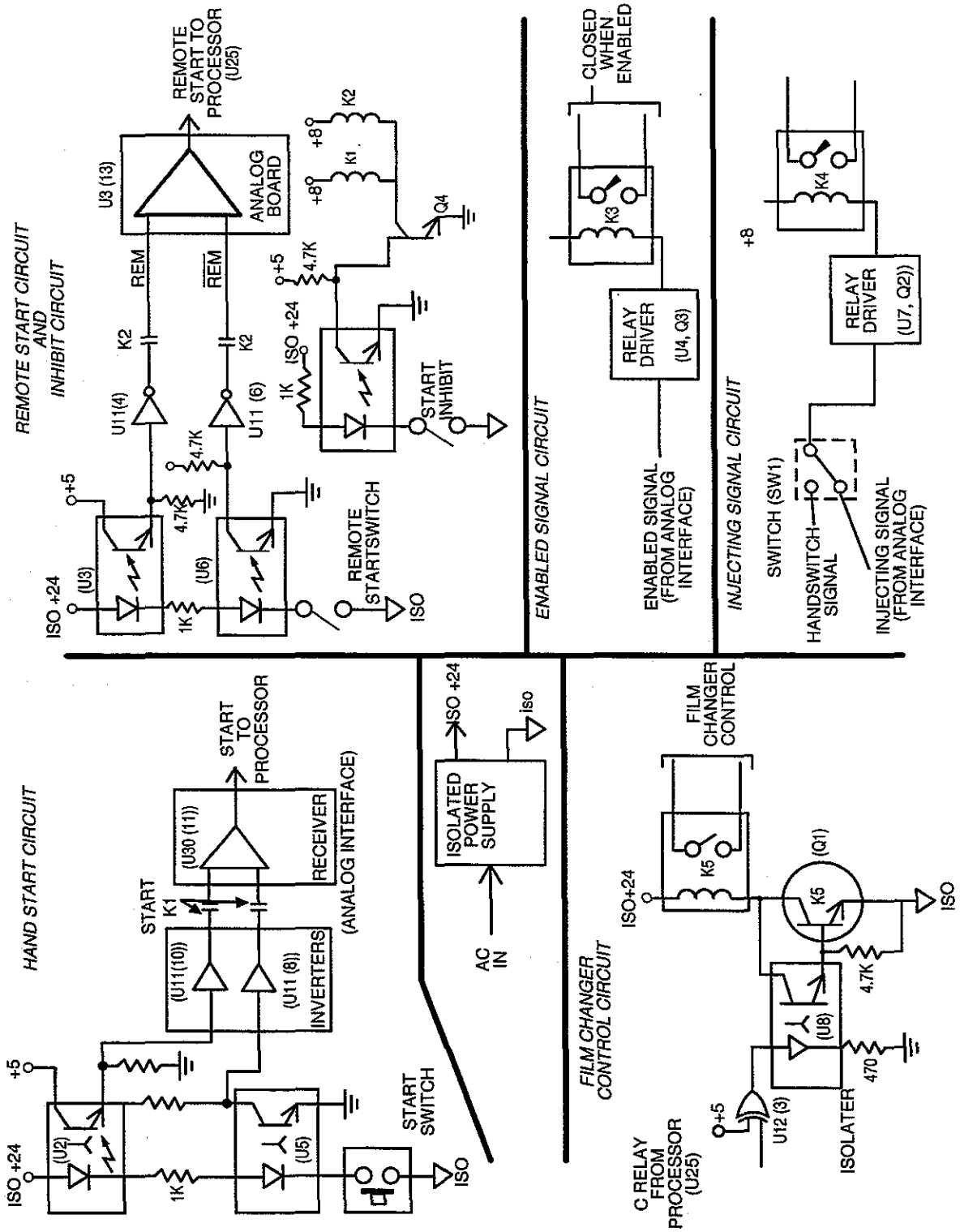


Figure 4-10
Universal Interface Block Diagram

POWER SUPPLY

The power supply provides DC power to most of the injectors circuits, to power the ICs and logic circuits. The powerhead, servo, and standard interface have their own supplies.

The power supply is contained on one circuit board in the base of the Angiomat 6000.

Major Functions

The power supply provides some AC and most DC voltages to the circuits in the injector base. These voltages are provided: +8.5 VDC, ±15 VDC, 20 VAC/CT, and 10 VAC.

The power supply also provides the termination for two grounding systems: one for digital circuits, and another for higher-power analog circuits.

Inputs and Outputs

The input to the power supply is switched AC line voltage from the servo board (from the power cord and power switch).

These voltages and grounds are the power supply's outputs:

Voltage	To/Function
+ 8.5 VDC	Processor, analog interface, servo, and ECG boards; on those boards, this is regulated down to + 5 VDC for logic circuits.
± 15 VDC	Analog interface, servo, and ECG boards; IC supplies.
20 VAC/CT	Power supply in head; for syringe heater.
10 VAC	Power switch light.
Digital ground	Most circuits; quiet ground for IC's and logic circuits.
Analog ground	Various circuits; high-power ground, for relays and other power-handling circuits.

Circuit Description

Transformer

AC line power comes into transformer TR1 from the servo board. A fuse (FU1) protects transformer TR1 from overloads. Jumpers at the primary terminals allow the transformer to operate on 110 or 220 VAC.

The secondary AC voltages from TR1 feed to the +8.5 VDC and ±15 VDC supplies. The secondary AC voltages also provide power to the powerhead for the ENABLE and INJECT lights and the syringe heater.

Unregulated DC Supply
This unregulated voltage is provided by U1 and Q1. C1 and C5 provide the filtering for this supply. This voltage is provided to each circuit board, which contains its own regulator to step the voltage down to +5 VDC for most of the digital logic circuits.

± 15 VDC Supply
The AC voltage from the transformer is doubled using components C2, C3, C6, C7 and D1 through D4. This doubled voltage feeds VR1 and VR2 (+15 VDC and -15 VDC regulators respectively), which are filtered by C8 and C9.

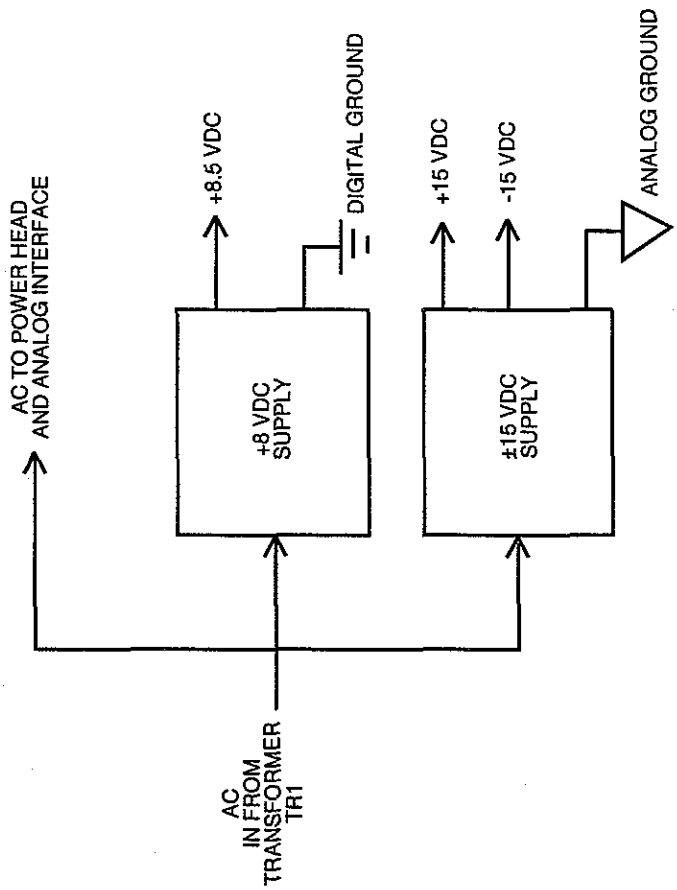


Figure 4-11
Power Supply Block Diagram

ECG TRIGGER (OPTIONAL)

The ECG Trigger board accepts high level analog input signals from an external amplifier and provides QRS detection pulses to the injector and optionally to any external equipment. The board also produces an analog signal as an output with superimposed marker signals which mark the beginning and end of ECG-triggered injections.

Inputs and Outputs

The input and output signals from ECG Trigger board are as follows:

Input	From/Function
High Level Voltage ECG signal (J1-3)	EXTERNAL AMPLIFIER; provides patient ECG signal in the form of a high level voltage to the ECG Trigger Board.
High Level Current ECG signal (J1-4)	EXTERNAL AMPLIFIER; provides patient ECG signal in the form of a high level current to the ECG Trigger Board.
+ 8.5 V (J3-7)	ANALOG INTERFACE; provides power for the purpose of generating isolated power on the patient side of the ECG Trigger Board.
Digital ground, ± 15 V Analog ground, + 5 V (J3-1, -4, -5, -6, -10)	ANALOG INTERFACE; provides power for the gain adjust circuitry on the ECG Trigger Board.
Marker Enable (J3-9)	ANALOG INTERFACE; enables and disables the generation of marker signals for addition to the patient's QRS waveform.
MODE (J3-2)	ANALOG INTERFACE; determines whether the gain will be adjusted automatically by the ECG Trigger Board or manually by the operator.
GAIN ADJUST (J3-3)	ANALOG INTERFACE; the gain provided to the ECG Trigger Board by the operator when in the manual mode.
PRESSURE (J1-7)	Not used.
SIGNAL GROUND (J1-5)	EXTERNAL AMPLIFIER; reference for the high level current and voltage input ECG signals.
PRESSURE (J2-1)	Not used.
+ 15 V UNREG. POWER GND (J1-1, -2)	EXTERNAL AMPLIFIER; provides a representation of the patient's QRS waveform with markers (if enabled).

R-WAVE (J3-8)	ANAGLO INTERFACE; provides a synchronization signal that allows the main processor to determine the patient R-wave-to-R-wave time interval.
R-WAVE SYNC. POWER GND (J2-4, -2) *ECG Output Pin 2*	EXTERNAL MONITORING EQUIPMENT; provides a 100 ms wide synchronization pulse externally at every patient R-wave.
SYNC. SIGN (J2-5) *ECG Output Pin 3*	EXTERNAL MONITORING EQUIPMENT; the polarity of this signal can be used to determine whether the R-WAVE SYNC pulse is active high or low.
SIGNAL GND (J2-6) *ECG Output Pin 4*	EXTERNAL MONITORING EQUIPMENT; provides a reference point internally for the voltage output signal at connector J2.

Major Functions

Marker Pulse Generation

In normal use with an ECG amplifier the output of the external amplifier is tied into the high level voltage input of the ECG option. The exact voltage level will be unknown but must lie within .25 and 2.0 Volts peak for proper operation of the ECG trigger. It is assumed that the external equipment is designed so that this unknown voltage amplitude will cause an appropriate deflection on a monitoring scope, if one is being used. For this reason, the ECG Trigger provides an output signal of the same amplitude as its input. If this signal is then sent to another channel on the monitoring scope with the same sensitivity, the same deflection will be seen.

In order to see the marker pulses on this signal, their amplitude must also vary with the amplitude of the input, to account for differing amplifier sensitivities. To accomplish this, the marker pulses are made the same height as the R-waves on the ECG signal. If the scope is properly adjusted to view R-waves, the marker pulses will be visible. These marker pulses are always of the opposite sign as the R-wave. That is, if the primary QRS deflection is positive, then the timing marker pulses are negative. The marker pulses are produced when the injector pulls the marker pulse enable line on the VIA low with the marker pulse occurring at the falling edge of the marker enable. This line must be raised to its high level within 25 ms for the marker pulse to be controlled by the ECG trigger to its nominal value of 25 ms

R-Wave Detection

Another function of the board, apart from the marker pulse generator, is the detection of R-waves. This circuit, too, must be able to adjust to differing input amplitudes. It has two modes: one totally automatic in which the circuit adjusts itself for R-wave triggering; the other manual, designed to be used if the automatic mode is unable to trigger properly. When an R-wave is detected, an appropriate pulse is sent to the injector over the R-wave line which pulses low. At the same time a 100 ms pulse is

sent to any external equipment over the R-wave sync. Iine which is available on pin 2 of the ECG output connector. The sense of this pulse may be chosen positive or negative, depending on whether the sync sign pin (pin 3 on the ECG output connector) is tied to signal ground with a jumper. This pulse is TTL compatible.

Manual Triggering
When manual triggering sensitivity is needed, the injector software must toggle the Auto/Manual Mode signal high. This disables the R-wave triggering amplitude tracking circuitry. Triggering levels are provided by the injector on the gain adjust pin tied to the D-to-A converter on the analog interface. To allow adequate resolution at low signal amplitudes, a non-linearity is provided to compress the finite steps from the D-to-A at allow voltages.

Isolation
All signals to external equipment are isolated from the injector power by optical isolators. This prevents any noise spikes on the input signal from becoming common node noise on the injector's circuits, causing possible inappropriate circuit operation due to induced signals caused by stray capacitance.

Circuit Description

Power Supply
To achieve the necessary isolation, a power supply isolated from the main injector power is used. This supply provides regulated ±15V, along with regulated +5V.

Q19 is the main inverter transistor, ramping the current in transformer T1. Q17 and Q18 form a timer which limits the on-time and thereby limits the collector current of Q19. The nominal value of the maximum on-time is controlled by resistor R95. Q16 and Q16 form a simple voltage error amplifier using the +5V from the analog interface as reference.

If the power supply is producing a voltage that is too high, the error amplifier causes Q16 to turn on, thereby increasing the discharge rate of C28. This shortens the on-time of Q17 and causes less energy to be stored in the transformer. A decrease in stored energy produces a corresponding decrease in output voltage. The feedback voltage is produced a secondary winding and diode D30 and capacitor C32. R99 provides some damping for the uncoupled energy in the flyback pulse producing a better analog of the secondary voltage. This feedback voltage is supplied to the error amplifier through R93 and R94 which divide to approximately 5V to be compared to the reference. In this way, a regulated +20V supply is made available.

In the isolated secondaries, several diodes and capacitors form isolated + and - 20V and isolated +8V. These are regulated to isolated + and - 15V by IC13, an LM325 voltage regulator, and an LM7805 (+5V voltage regulator).

Peak QRS Amplitude Generation
Operation of the QRS and detection circuitry is best seen by following the signal path throughout its processing. A voltage input is supplied to pin 3 of J1 and amplified by IC12, while a current input from the ECG preamplifier is changed to a by current -to-voltage converter IC1-1. A current is used to transmit the analog signal from the ECG preamp to increase noise immunity. The two signals are then summed by IC12, then output back to the user's scope by IC1-2, with a total gain of 1. This produces an ECG signal for the scope with the same amplitude as the input. Marker pulses are added to the output by injecting a current in R12 which is made proportional to the R-wave height.

IC1-4 and IC1-3 form an absolute value circuit. The sign of this signal is given by IC1-3, which acts a comparator. This is then fed into 1/2 of IC11, a D flip-flop, which remembers the sign (whether the peak is above or below the baseline) of the R-wave. This is done so that the marker pulse can have the opposite polarity of the R-wave peak. IC1-4 has a gain of +1 and -1, depending on the state of 01. Since Q1 is gated by the sign, the output of IC 1-4 is the negative absolute value of its input, and can be measured at test point 1 (TP1), called "ABS" (absolute value).

Diode D17 allows the peak value to be stored in capacitor C8, while Q10 resets the peak storage capacitor between beats to enable it to find a new peak on a beat-to-beat basis. FET Q13 strobes the peak voltage into capacitor C7. This voltage is then available at TP3 for peak value (PEAKV). IC4-3 and Q9 form a voltage-to-current converter which is gated by the signal at the gate of Q9. When a marker is to be produced, the injector pulses the marker enable line low, triggering the NE555 one-shot. The resulting pulse is optically coupled across the isolation by OP2 and applied to the gate of Q9 after appropriate level shifting by Q8. The other half of IC2 uses the sign of the peak, stored previously in the sign of FF, to produce an output current of a polarity determined by the sign. Since the output current of IC2-2 is proportional to the R-wave peak voltage, gated by the timing pulse, and of appropriate sign, a voltage output occurs which is directly equal to the R-wave peak height and of the proper sign.

Strobe Generator
Timing pulses for the peak detection process are provided by some additional logic and a timing generator, consisting mainly of IC9. Assume that a negative R-wave detection pulse is applied to IC7, pin 1, the input of the timing generator. The gate at this input prevents re-triggering of the timing generator during a certain refractory period and rejects waveforms with unrealistic R-wave rates. The R pulse sets FF2 of IC11, which provides a stretched and validated R-wave pulse for output through IC10, a one-shot. The output of this one-shot can be switched in sign by grounding the sync sign pin. This is done because different external equipment my be triggered by negative or positive edges. The R-pulse is also sent to the microprocessor through OP1 and enables the peak detection process through Q2.

A secondary flip-flop, formed by cross-coupled gates in IC7, is also set at this time and produces the refractory period signal available on TP6. One of the outputs enables a capacitive ramp generator formed by Q7, C11, and R72. As the capacitor charges, strobe pulses are produced by the bar graph LED driver. The first strobe pulse, PSTROBE, strobes the peak value of the R-wave into C7. Successive strobe pulses first reset the peak detector via PRES, peak reset, then clear the R-wave output FF IC11-2, and finally clear the refractory FF made from IC7. Thus, the strobe pulses are sequenced to 1) enable the peak detection process, 2) find the peak and store its value and then 3) reset itself.

R-Wave Detector

R-Waves are detected by slope detector IC4-1. Current through capacitor C14 at the summing junction of IC4-1, which is proportional to dv/dt of the ECG, is balanced by current from voltage-to-current converter IC4-2. If the current from dv/dt is greater than IC4-2's output current, then feedback across D17 is lost and a very large output pulse is produced at pin 8. This pulse is conditioned by inverters in IC3, producing a short pulse occurring at the leading edge of the R-wave at a time of high slope. Automatic gain adjustment is provided by changing the magnitude of the current injected into IC4-1's summing junction. If this current is large, then a large value for dv/dt will be required to trip the detector. Similarly, if this current is small, then a lesser value for dv/dt will be required to trip the detector. The transistors in IC6 provide a means of adjusting this balance so that only the point of maximum slope in the signal is found. This section is enabled only in the automatic mode and is inhibited in manual mode by a current through D24.

Manual Mode Control

In manual mode some form of transmission of DC voltages across the isolation is needed. This is accomplished by first changing the DC voltage to a pulse width-modulated waveform, sending the pulses through an optical coupler, and averaging the pulse train on other side. A non-linearity is used to increase the precision of this DC voltage for very small values. This is due to the fact that the control voltage will be produced a D-to-A converter on the analog interface and the step size would be much too large to adjust sensitivity for small ECG input amplitudes.

The non-linearity is produced by IC5-A and diodes D26 and D27. Remaining sections of IC5 form a conventional pulse width modulator, with its on pulses transmitted to the isolated side by OP3. After averaging by R68 and C22, which transforms the signal back to a DC level, the voltage is buffered by IC4-4, which has additional components to prevent the control voltage from becoming negative. In manual mode the sensitivity control voltage derived from the pulse width modulation scheme is applied to IC4-2 through Q11. The manual gain control voltage can be seen at TP11, MGNE, for manual gain.

5 TROUBLESHOOTING

The intent of this Chapter is to deliver information to the service technician in order to track a problem to a board or subassembly so it can replaced or repaired. When a problem exists with the Angiomat 6000, a error code will be displayed on the system display. A complete listing of these error codes and their probable causes is contained in this chapter. A few faults, however, will not display error codes. These non-error code faults are covered separately in this chapter.

Included at the end of this Chapter are instructions covering the disassembly and reassembly of the major injector components.

TOOLS AND TEST EQUIPMENT REQUIRED

These tools are required to gain access to the boards and wiring in the Angiomat 6000 for troubleshooting and calibration.

- Hex (Allen) wrench, set
- 1/8 flat blade screwdriver
- 1/4 flat blade screwdriver
- Medium Philips head screwdriver
- Small Philips head screwdriver
- Nut drivers, set
- Needle-nosed Pliers

These items are used for narrowing down the causes of problems, and in calibration procedures after replacements.

- Oscilloscope, 50 MHz, dual-trace
- Digital Voltmeter, 3-1/2 digit
- IC Clips, 12-, 14-, 16-, 20—, 24- and 40-pin
- Jumper lead

GENERAL TROUBLESHOOTING GUIDELINES

We suggest these actions when first troubleshooting the Angiomat 6000; things to try before taking anything apart, and to make the job easier.

1. **Disconnect external equipment.** Be sure to disconnect any film changer, programmer, or other external equipment from the Angiomat 6000.
2. Verify the problem. Check the injector under the same conditions and settings that it had when the problem occurred. Then try the injector in an isolated setting, in a different room, to see if the problem can be duplicated.
3. Try different settings. Check the injector with different control settings than it had when the problem occurred. Change the flow rate, volume, and pressure. If another size syringe is available, try it.
4. Use the checkout in Chapter 4. This is a relatively quick way to check the major functions. This is especially helpful if the accuracy is in question.
5. Visually inspect the subassemblies and components. Before performing electrical tests or calibration procedures, open the base cover and visually inspect all boards and cables. Specifically make sure the integrated circuits are firmly in their sockets; the cable plugs are tight on the boards; connectors are tight, with their wires firmly attached. If the trouble is in the powerhead, open the covers and inspect the powerhead while it operates. Look for loose parts, loose connections, interference, and wear.
6. Isolate the fault. While trying different settings, and under different conditions, try to isolate the specific problem.
7. Call your sales representative for service assistance, field service, and for replacement parts or modules. If the system is new, still under warranty, or covered under a service contract, call your sales representative before proceeding.

DANGER! SHOCK HAZARD.
Be extremely careful when the Angiomat 6000 is open. Lethal voltages are exposed. Be careful not to leave an open system unattended with power plugged in. DISCONNECT THE POWER CORD BEFORE REMOVING OR REPLACING BOARDS.

DANGER! SHOCK HAZARD—LINE OPERATED SERVO.
Be extremely careful when troubleshooting the servo. It is line operated and not isolated. Lethal voltages are exposed. Be careful when making measurements and inspections. DISCONNECT THE POWER CORD BEFORE TOUCHING ANY COMPONENTS ON THE SERVO BOARD, AND BEFORE REMOVING OR REPLACING THE SERVO BOARD.

NON-MESSAGE FAULTS

With these faults, there is no error code on the system display. The faults below are discussed on the following pages. With each fault is a summary of the symptoms, probable cause, and what action to take to try to remedy the problem.

KEYBOARD CONSOLE LED'S NOT INDICATING PROPERLY

Symptoms: One or more of the LEDs do not light.

Cause: The LED is probably defective or there is an open connection to the circuit or board.

Check: Check all LED's on the control panel at once with this test:

1. Turn off power. Open the powerhead.
2. Install a jumper in the powerhead from J8 pin 2 to the negative side of capacitor C4.
3. Turn on power. After the power-up tests, press the Special key twice. The System Display will state:

   ENTER COMMAND

4. Enter D-E-B, then press the START key.
5. Turn off power, then turn on again.
6. Within a few seconds, the System Display will state:

   CHECK LIGHTS PLEASE

   All LEDs on the control panel should light. If not, check the LED and its connections to the circuit board. If this checks out, check the LED-driving circuit. Press the SPECIAL key twice and repeat step 4 to deactivate the mode.

7. Turn off power and remove the jumper in the powerhead. Reassemble the powerhead.

ERROR CODES

When the Angiomat 6000 detects a fault requiring service, it displays a "Call Service" advisory along with the appropriate error code number:

CALL SERVICE. ERROR CODE 31

The error codes are listed in the following table. Following the table, each error code includes a description of what it means, probable causes, and what action to take to remedy the problem. From this section, the defective subassembly (such as a circuit board or the powerhead) can be identified and replaced.

There are two types of error code faults: major and minor. A major fault stops the powerhead and causes the INJECTING light on the powerhead to blink, whether or not a error code is displayed. The INJECTING light on the powerhead can show a major fault if the console is defective and can't display any error codes. A major fault can only be reset by turning power off, then on again.

A minor fault, on the other hand, does not stop the injector or cause the INJECTING light to blink. There will still be a error code on the system display, but the injector can be operated without interruption. The INJECTING light on the powerhead can show a problem even if the console is defective and cannot display any error codes.

ERROR CODE #	SYSTEM DISPLAY MESSAGE
6	CHECKSUM ERROR ON SAVED INJECTION
7	DAC FAILURE
9	FLOW ERROR
10	FLOW ERROR DETECT ERROR
11	HEAD COMM ERROR DETECT FAILURE
14	INCREMENTAL ENCODER FAILURE
17	LOST CORRELATION BETWEEN POT AND CHOPS
18	POSITIONAL ERROR
19	POSITIONAL DAC TOLERANCE ERROR
21	POSITIONAL POT DISCONNECTED
23	PRESSURE DAC TOLERANCE ERROR
24	PRESSURE ERROR
25	PRESSURE ERROR DETECT ERROR
27	RAM ERROR
28	ROM CHECK ERROR
29	SAFE RELAY IMPROPERLY ENGAGED
32	SERVO OUTPUT SHORT
34	POWER FAILURE
36	SYNC ERROR
37	SYNC ERROR DETECT FAILURE
38	SYRINGE SIZE SENSING SWITCHES IN ERROR
42	WATCHDOG RESET ERROR
44	NO ERROR INTERRUPT DURING HEAD COMMUNICATIONS ERROR DETECT
45	NO ERROR INTERRUPT DURING POSITION ERROR DETECT

Error Code 6: CHECKSUM ERROR ON SAVED INJECTION

Meaning: An injection recalled from memory has been altered in some way and is no longer valid.

Cause: Operator has inadvertently changed a byte in injection memory or injection memory circuitry is not functioning properly.

Check: Consult Operator's manual for injection SAVE procedure and check injection memory. Check injection memory circuitry on main processor board.

Error Code 7: DAC FAILURE

Meaning: The data sent to the analog interface from the processor (which goes through a D-to-A converter, then an A-to-D converter) does not match the data coming back to the processor.

Cause: Defective digital-to-analog-to-digital loop.

Check: Check the data conversion loop (U9, U22, U21, U31, U33) on the analog interface board.

Error Code 9: FLOW ERROR

Meaning: The actual flow rate has exceeded the desired flow rate.

Cause: The FLOWERR signal is active into the hard error latch (U4) on the analog interface board.

Check: Check the flow control circuits on the analog interface board, and the circuits on the servo board that provide the actual flow rate signal.)

Error Code 10: FLOW ERROR DETECT ERROR

Meaning: While checking the flow rate circuit during the power-up tests, a fault was simulated and was not detected. This doesn't mean the main flow circuit is defective; this checks the backup.
Cause: Flow error detector and circuit.

Check: Check the flow error detector (U8 pin 2) and its associated circuit on the analog interface board.

Error Code 11: HEAD COMM ERROR DETECT FAILURE

Meaning: The system has simulated a fault in the communication link between the powerhead and the analog interface, and the fault was not detected .

Cause: There is a defect in either the powerhead or the analog interface, specifically the RS-422 interface circuit on the analog interface board, or the RS-422 interface circuit in the powerhead.

Check: To check the RS-422 interface circuit on the analog interface board, check the powerhead clock signal being sent to the powerhead from the analog interface. The powerhead clock circuit or the RS-422 driver (U34) may be defective.

To check the RS-422 interface circuit in the powerhead, check the RS-422 receiver (U6) in the powerhead.

Error Code 14: INCREMENTAL ENCODER FAILURE

Meaning: No signal is being received from the incremental encoder in the powerhead.
Cause: Either defective encoder or circuit (in the powerhead) or defective decoder board in the analog interface.

Check: Check the incremental encoder circuit:

1. Turn off power and disassemble the powerhead.
2. Turn on power.
3. Using a dual-trace scope, monitor pins of 10 and 11 of U17. These test points are shown in Chapter 6.
4. Run the injector with the forward load switch. The waveforms should look like those shown in Chapter 6; if they do not, either the decoder or its circuit is defective.

If the signals are correct, the *multiplexer* (in the powerhead) may be defective. Check the decoder circuit:

1. Check U18.
2. Check U6 and U16.

Error Code 17: LOST CORRELATION BETWEEN POT AND CHOPS

Meaning: During an injection the processor sent out pulses that were not matched by movement in the pot position-generating circuitry.

Cause: Pot is not moving or position-generating circuitry not functioning properly

Check: Check pot, pot drive, pot position-generating circuitry or microprocessor pulse-generating circuitry.

Error Code 18: POSITIONAL ERROR

Meaning: Either the position pot (in the powerhead) needs readjusting, or the pot has become mechanically disconnected, or an end limit requires adjustment or replacement.

Cause: An end limit is reporting the position of the ram at the corresponding limit while the pot is reporting the ram position between the end limits.

Check: First, the position of the pot is checked at the forward and reverse limits. If the error code appears because of this, the pot needs to be readjusted. Refer to the Chapter 6—Calibration for the procedure to set the position pot. Second, an end limit is defective and falsely reporting a limit condition. Check the end limit on the Heater Controller PC board and/or the Head Status Transmitter PC board. Repair or replace as necessary.

(MCA-8 on both the Heater Controller PC board and Head Status Transmitter PC board.) After any pot repairs, refer to Chapter 6—Calibration for the procedure to set the position pot.

Error Code 19: POSITION DAC TOLERANCE ERROR

Meaning: The position signal sent to the analog interface from the processor (which goes through a D-to-A converter, then an A-to-D converter) does not match the data coming back to the processor. This position signal is used for the backup volume circuit to function as an "electronic stop" to prevent an over-volume injection.

Cause: There is probably a defect in the digital-to-analog-to-digital loop.

Check: Check the data conversion loop (U9, U22, U21, U31, U33) on the analog interface board.

Error Code 21: POSITIONAL POT DISCONNECTED

Meaning: The POTERR signal is active into the hard error latch (U4) on the analog interface board.

Cause: The wiper of the pot in the powerhead has exceeded the preset limits, so it is probably open or disconnected.

Check: Check the pot in the powerhead, and the connections between the powerhead and the analog interface board.

Error Code 23: PRESSURE DAC TOLERANCE ERROR

Meaning: The pressure signal to the analog interface from the processor-which goes through a D-to-A converter, then an A-to-D converter—does not match the data coming back to the processor

Cause: There is probably a defect in the digital-to-analog-to digital loop

Check: Check the data conversion loop (U9, U22, U21, U31, U33) on the analog interface board.

Error Code 24: PRESSURE ERROR

Meaning: The PRESERR signal is active into the hard error latch (U4) on the analog interface board.

Cause: The actual pressure has exceeded the desired pressure.

Check: Check the pressure circuits on the analog interface board and the servo board.

Error Code 25: PRESSURE ERROR DETECT ERROR

Meaning: While checking the pressure circuit during the power-up tests, a fault was simulated and was not detected.

Cause: The main pressure circuits are functioning, but the fault detection circuit is defective.

Check: Check the pressure error detector (U8 pin 14) and its associated circuit on the analog interface board.

Error Code 27: RAM ERROR

Meaning: The RAM for the main processor has failed the power-up tests.

Cause: The main processor RAM is probably defective.

Check: Replace the RAM (U10) on the main processor board, or replace the main processor board.

Error Code 28: ROM CHECK ERROR

Meaning: The ROM for the main processor has failed the power-up tests.

Cause: The ROM chip (U7) on the main processor board is probably defective. Replace this chip if necessary.

Error Code 29: SAFE RELAY IMPROPERLY ENGAGED

Meaning: The processor is receiving a signal from the servo that the safe relay is closed when it shouldn't be.

Cause: Defective safe relay sensing circuit.

Check: The relay is probably not closed; the sensing circuit in the safe relay circuit on the servo board is probably defective (Q13 may be shorted), sending a SR CLOSED signal back to the processor.

Error Code 32: SERVO OUTPUT SHORT

Meaning: An overload is pulling down the servo output.

Cause: During standby, the servo output should be about 5 VDC; if not, this error code appears.

Check: There is probably a short in the brake circuit (Q11, VR2) on the servo board.

Error Code 34: SERVO POWER FAILURE

Meaning: The POWERR signal is active into the hard error latch (U4) on the analog interface board.

Cause: The +35 VDC supply dropped below its threshold, or the supply has completely failed.

Check: First check for low AC line voltage. The line voltage must be within the limits specified on the label on the back of the column.

If the line voltage is proper, check the +35 VDC supply on the servo board.

Error Code 36: SYNC ERROR

Meaning: The SYNCERR signal is active into the hard error latch (U12) on the analog interface board.

Cause: The charge pump loop (velocity correction loop) has not maintained zero velocity error.

The error code will also appear during an injection (such as for a low flow rate) if the motor is turned by hand. If the motor was just turned by hand (using the piston control knob on the back of the powerhead), just turn off the injector, then turn it back on and continue. If the motor was not turned back by hand, check the charge pump and velocity circuits on the analog interface board.

Error Code 37: SYNC ERROR DETECT FAILURE

Meaning: While checking the velocity circuit during the power-up tests, a fault was simulated and was not detected.

Cause: A pulse train was fed into the velocity circuit, and the correction loop didn't respond properly.

Check: Check the sync error detector (U1 pin 1) charge pump (U2) and their associated circuits on the analog interface board.

Error Code 38: SYRINGE SIZE SENSING SWITCHES IN ERROR.

Meaning: The size can't be defined from the sensing switches (in the powerhead).

Cause: The sensing switches, activated by the syringe plate, are in an undefined state.

Check: The sensing pins may be mechanically damaged, or the limit switches may be defective or clogged (with contrast medium).

Error Code 41: VOLUME ERROR

Meaning: The VOLERR signal is active into the hard error latch (U4) on the analog interface board. The actual position (relating to actual volume) has exceeded the desired position.

Cause: The backup position circuit (using the position pot) is now controlling the volume; the encoder circuit has failed to stop the injection after the desired volume was delivered.

Check: Check the position circuits—the primary ones, using the encoder pulse train to control position—on the analog interface board. Also check the encoder circuit in the powerhead.

Error Code 42: WATCHDOG RESET ERROR

Meaning: The CPU on the main processor board has failed to receive a RESET signal from the watchdog circuit during power-up testing.

Cause: The main processor is probably defective.

Check: Check the CPU (U1) and the watchdog circuit (U16) on the main processor board, or replace the main processor board.

Error Code 44: NO ERROR INTERRUPT DURING HEAD COMMUNICATIONS ERROR DETECT

Meaning: During the HEAD COMMUNICATIONS ERROR DETECT power-up test, the LO-FAIL interrupt signal used to indicate a major hardware failure is not functioning properly.

Cause: The LO-FAIL interrupt circuitry on the Analog Interface Board is not working.

Check: Check U25, U28, U14, and U13 on the Analog Interface Board.

Error Code 45: NO ERROR INTERRUPT DURING POSITION ERROR DETECT

Possibility #1

Meaning: During power-up tests, the LO-FAIL interrupt line on the Analog Interface Board has remained in a low (logic 0) state.

Cause: One of 7 possible major hardware errors has occurred at U4, the ERROR LATCH, on the Analog Interface Board.

Check: Check pins 3, 4, 7, 8, 13,14,17 and 18 of U4 on the Analog Interface Board. The pin(s) that is (are) stuck in a low state is (are) indicating the problem area(s).

Possibility #2

Meaning: The LO-FAIL interrupt signal used to indicate a major hardware failure is not functioning properly when tested during the POSITION ERROR DETECT power -up test.

Cause: The LO-FAIL interrupt circuitry on the Analog Interface Board is not working.

Check: Check U11, U5, U14, and U13 (the LO-FAIL interrupt circuitry) on the Analog Interface Board.

DISASSEMBLY AND REASSEMBLY PROCEDURES

This section describes how to disassemble and reassemble the major components of the Angiomat 6000 system. After each major item are procedures for removal and replacement of its circuit boards. The powerhead section also includes procedures for removing and replacing other components.

Be sure the power cord is unplugged before proceeding. Lethal voltages are exposed when the power cord is plugged in and the injector is disassembled.

PEDESTAL BASE

These procedures are for the disassembly and reassembly of the injector base (pedestal models) and their circuit boards.

Base Disassembly Procedure

Refer to Figure 5-1.

1. Remove the Allen screw holding the right front corner of the base cover.
2. Under the three corners, slide the retainer clips away from the base to unlock them.
3. Lift the cover to remove it from the base.

Base Reassembly Procedure

Refer to Figure 5-1.

1. Place the cover over the base.
2. Under the three corners, slide the retainer clips toward the base to lock them.
3. Install and tighten the Allen screw to the right front corner.

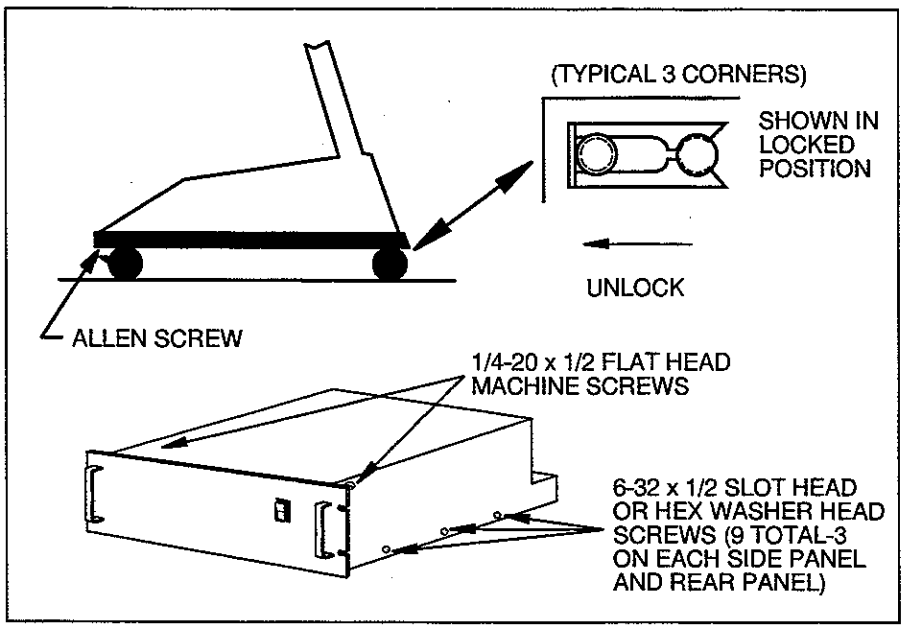

(TYPICAL 3 CORNERS)
SHOWN IN LOCKED POSITION
UNLOCK
ALLEN SCREW
1/4-20 x 1/2 FLAT HEAD MACHINE SCREWS
6-32 x 1/2 SLOT HEAD OR HEX WASHER HEAD SCREWS (9 TOTAL-3 ON EACH SIDE PANEL AND REAR PANEL)

Figure 5-1
Base Disassembly Reassembly

Power Supply Board Removal

Refer to Figure 5-2.

1. Unplug the two connectors on the power supply board.
2. Remove the four 6-32 screws holding the board to the standoffs on the support column.
3. Lift out the power supply board.

Power Supply Board Replacement

1. Place the board in the pedestal base and line up the holes in the board with the standoffs on the support column.
2. Install and tighten the four 6-32 screws to retain the board.
3. Plug the two connectors into the power supply board.

Servo Controller Board Removal

Refer to Figure 5-2.

1. Unplug the connector (P4) and the ribbon cable (P3) on the servo controller board.
2. Slide the board up to unplug and remove it from the servo bottom board.

Servo Controller Board Replacement

1. Slide the board down the card guides on the servo bottom board. Carefully insert the plug-in board into the connectors on the main board.
2. Plug the connector (P4) and ribbon cable (P3) into the servo controller.

Servo Top Board Removal

Refer to Figure 5-2.

1. Unplug connectors P1 through P4 on the servo top board.
2. Remove the two hex nuts and three 6-32 screws holding the board to the standoffs in the Pedestal Base.
3. Lift out the servo top board.

Servo Top Board Replacement

1. Place the board in the base assembly and line up the holes in the board with the standoffs in the bottom of the base.
2. Install and tighten the hex nuts and screws to retain the board.
3. Plug the four connectors into the servo top board.

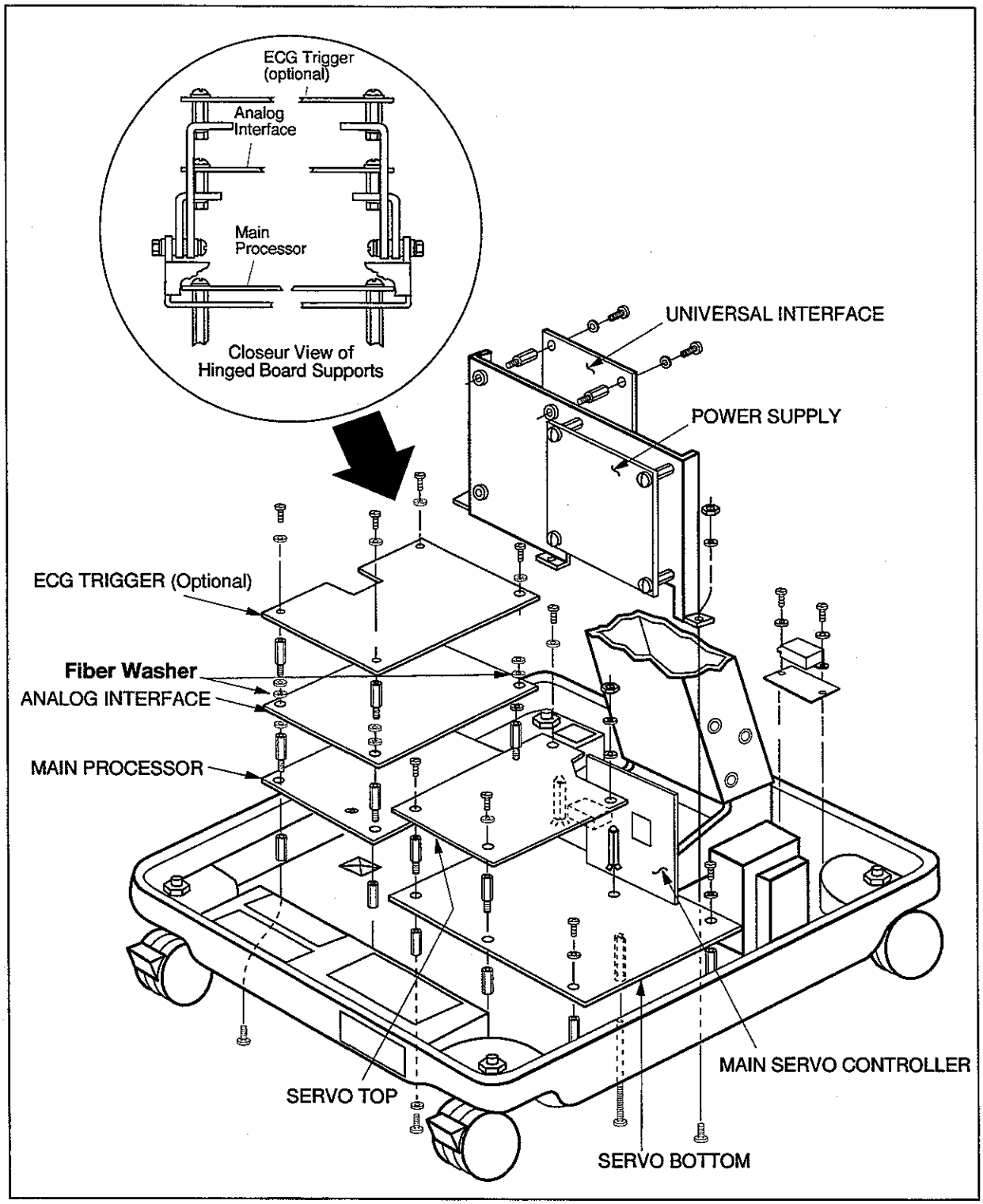


Figure 5-2
Removing/Replacing Circuit Boards In Pedestal Base Assembly

Servo Bottom Board Removal

Refer to Figure 5-2.

1. Remove the servo controller board (see previous section).
2. Remove the servo top board (see previous section).
3. Unplug the four connectors on the servo bottom board.
4. Remove the two hex nuts and four hex standoff sections securing the servo bottom board to the base assembly.
5. Lift out the servo bottom board.

Servo Bottom Replacement

1. Place the board in the base assembly and line up the holes in the board with the standoffs.
2. Install and tighten the two hex nuts and four hex standoff sections (for servo top board) to retain the board to the base.
3. Plug the four connectors into the servo bottom board.
4. Install the servo top board (see previous section).
5. Install the servo controller board (see previous section).

Optional ECG Trigger Board Removal

See Figure 5-2.

With the hinge standoff system, removing the front two 6-32 screws from the top PC Board will enable the ECG board to hinge and allow access to the other boards.

1. Unplug the connectors and ribbon cables attached to the board.
2. Remove the four, 6-32 screws that secure the board to the standoffs and board hinge assembly underneath.
3. Lift out the ECG Trigger board.

Optional ECG Trigger Board Replacement

1. Line up the board with the standoffs on top of the analog interface board.
2. Reinstall the four, 6-32 screws that secure the board to the standoffs and board hinge assembly underneath.
3. Re-attach the connectors and ribbon cables to the board.

Analog Interface Board Removal

Refer to Figure 5-2.

1. Remove the ECG Trigger Board, if so equipped. Unplug the ribbon cables and connectors on the board.
2. Remove the 6-32 screw on each standoff. Lift each corner of the board and remove it from the standoffs. When the corners are free, lift the board out of the base.

Analog Interface Board Replacement

1. Line up the corner holes in the analog interface board with the standoffs on the main processor board and hinge assembly.
2. Reinsert the 6-32 screws to fasten the board to the standoffs and hinge assembly.
3. Re-attach the connectors and ribbon cables.
4. Reinstall the ECG Trigger Board if so equipped.

Main Processor Board Removal

Refer to Figure 5-2.

1. First remove the analog interface board and ECG board, if installed (see previous section).
2. Unplug the ribbon cable and connectors on the main processor board.
3. Remove the four hex standoff sections holding the main processor board to the base.
4. Lift out the main processor board.

Main Processor Board Replacement

1. Place the main processor board in the base and line up the four holes in the board with the standoffs underneath.
2. Install and tighten the four hex standoff sections to secure the board.
3. Plug the ribbon cable and connectors into the main processor board.
4. Install the analog interface board and ECG Trigger Board, if so equipped.

Universal Interface Board Removal

Refer to Figure 5-2.

1. Unplug the connectors to the Universal Interface Board.
2. Remove the four 6-32 screws that secure the board to the standoffs on the PCB support bracket just in front of the support column.
3. Lift the board out of the base.

Universal Interface Board Replacement

1. Line up the holes each corner of the board with the standoffs on the PCB support bracket.
2. Re-attach the four 6-32 screws to the standoffs to secure the board.
3. Re-attach the connectors to the board.

ELECTRONICS CABINET

These procedures are for the disassembly and reassembly of the electronics cabinet (rack mount or table-top models) and their circuit boards.

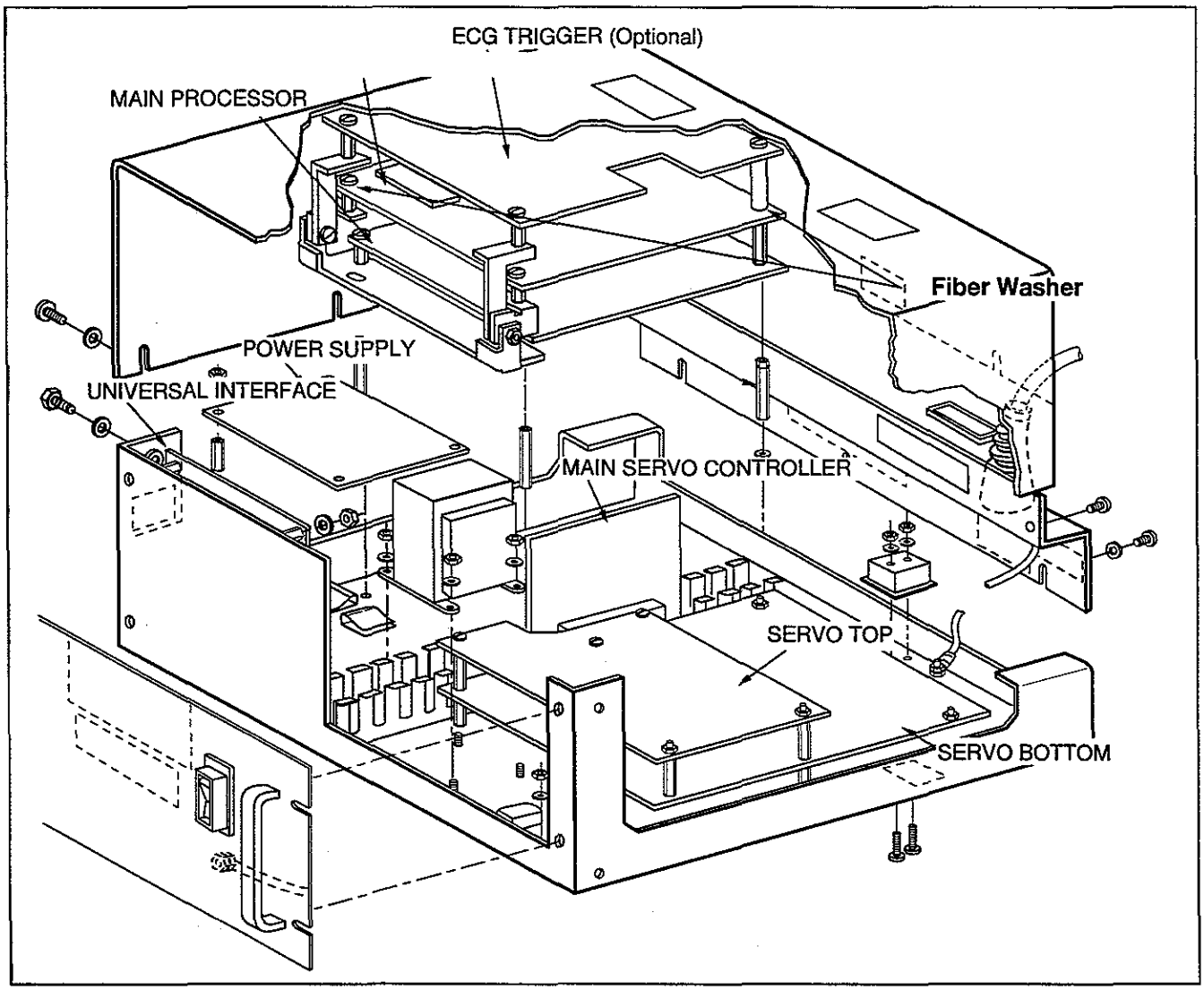


Figure 5-3
Removing/Replacing Circuit Boards In Electronics Cabinet

Electronics Cabinet Disassembly

Refer to Figure 5-3.

1. Remove the 6-32 x 1/2 slot head or hex washer head screws securing the electronics cabinet cover. There are nine (9) of these fasteners, three (3) each on the right and left sides and three (3) on the rear.
2. Remove the two (2) 1/4-20 x 1/2 flat head machine screws in the upper front corners of the right and left sides of the cabinet.
3. Lift the cover to remove it from the electronics cabinet.

Electronics Cabinet Reassembly

1. Place the cover over the electronics cabinet.
2. Reinsert the 1/4-20 x 1/2 screws in the upper front corners; reinsert the 6-32 x 1/2 screws in the side and rear panels.
3. Tighten all screws to secure the cover.

Power Supply Board Removal

Refer to Figure 5-3.

1. Unplug the two connectors on the power supply board.
2. Remove the four hex nuts holding the board to the standoffs in the electronics cabinet.
3. Lift out the power supply board.

Power Supply Board Replacement

1. Place the board in the electronics cabinet and line up the holes in the board with the standoffs.
2. Install and tighten the four hex nuts to retain the board.
3. Plug the two connectors into the power supply board.

Servo Controller Board Removal

Refer to Figure 5-3.

1. Unplug the connector (P4) and the ribbon cable (P3) on the servo controller board.
2. Slide the board up to unplug and remove it from the servo bottom board.

Servo Controller Board Replacement

1. Slide the board down the card guides on the servo bottom board. Carefully insert the plug-in board into the connectors on the main board.
2. Plug the connector (P4) and ribbon cable (P3) into the servo controller.

Servo Top Board Removal

Refer to Figure 5-3.

1. Unplug connectors P1 through P4 on the servo top board.
2. Remove the two hex nuts and three 6-32 screws holding the board to the standoffs in the electronics cabinet.
3. Lift out the servo top board.

Servo Top Board Replacement

1. Place the board in the electronics cabinet and line up the holes in the board with the standoffs.
2. Install and tighten the hex nuts and screws to retain the board.
3. Plug the four connectors into the servo top board.

Servo Bottom Board Removal

Refer to Figure 5-3.

1. Remove the servo controller board (see previous section).
2. Remove the servo top board (see previous section).
3. Unplug the four connectors on the servo bottom board.
4. Remove the two hex nuts and four hex standoff sections securing the servo bottom board.
5. Lift out the servo bottom board.

Servo Bottom Board Replacement

1. Place the board in the electronics cabinet and line up the six holes in the board with the standoffs in the electronics cabinet plate.
2. Install and tighten the two hex nuts and four hex standoff sections (for servo top board) to retain the board to the electronics cabinet base.
3. Plug the four connectors into the servo bottom board.
4. Install the servo top board (see previous section).
5. Install the servo controller board (see previous section).

Optional ECG Trigger Board Removal

See Figure 5-3.

With the hinge standoff system, removing the front two 6-32 screws from the top PC Board will enable the ECG board to hinge and allow access to the other boards.

1. Unplug the connectors and ribbon cables attached to the board.
2. Remove the four, 6-32 screws that secure the board to the standoffs and board hinge assembly underneath.
3. Lift out the ECG Trigger board.

Optional ECG Trigger Board Replacement

1. Line up the board with the standoffs on top of the analog interface board.
2. Reinstall the four, 6-32 screws that secure the board to the standoffs and board hinge assembly underneath.
3. Re-attach the connectors and ribbon cables to the board.

Analog Interface Board Removal

Refer to Figure 5-3.

1. Remove the ECG Trigger Board, if so equipped. Unplug the ribbon cables and connectors on the board.
2. Remove the 6-32 screw on each standoff. Lift each corner of the board and remove it from the standoffs. When the corners are free, lift the board out of the base.

Analog Interface Board Replacement

1. Line up the corner holes in the analog interface board with the standoffs on the main processor board and hinge assembly.
2. Reinsert the 6-32 screws to fasten the board to the standoffs and hinge assembly.
3. Plug the connectors and ribbon cables into the analog interface board.
4. Reinstall the ECG Trigger Board if so equipped.

Main Processor Board Removal

Refer to Figure 5-3.

1. First remove the analog interface board and ECG board, if installed (see previous section).
2. Unplug the ribbon cable and connectors on the main processor board.
3. Remove the four hex standoff sections holding the main processor board to the electronics cabinet.
4. Lift out the main processor board.

Main Processor Board Replacement

1. Place the main processor board in the electronics cabinet and line up the four holes in the board with the standoffs in the electronics cabinet.
2. Install and tighten the four hex standoff sections and 6-32 screws to secure the board.
3. Plug the ribbon cable and connectors into the main processor board.
4. Install the analog interface board and ECG Trigger Board, if so equipped.

Universal Interface Board Removal

Refer to Figure 5-3.

1. Unplug the connectors to the Universal Interface Board.
2. Remove the four hex nuts that secure the board to the standoffs on the inside front panel.
3. Lift the board out of the cabinet.

Universal Interface Board Replacement

1. Line up the holes each corner of the board with the standoffs on the inside front panel of the cabinet.
2. Re-attach the four hex nuts to the standoffs to secure the board.
3. Re-attach the connectors to the board.

KEYBOARD CONSOLE

These procedures are for the disassembly and reassembly of the keyboard console.

Keyboard Console Disassembly

Refer to Figure 5-4.

1. Place the unit upside-down on a padded surface.
2. Remove the four screws in the bottom covers.
3. Carefully line up the bottom cover slightly and to the left. Look inside for the main cable connected to the circuit board. Unplug the cable connector on the board.
4. Lift off the bottom cover and set aside.

Keyboard Console Reassembly

1. With the unit upside-down on a padded surface, place the bottom cover over the unit. Lift up the cover slightly and plug the main cable connector into the circuit board.
2. Install and tighten the four screws to retain the bottom cover.

POWERHEAD

These procedures are for the disassembly and reassembly of the powerhead, its circuit boards, and the following field-replaceable components: Head Scale, Heater Controller Board, Head Status Transmitter board, Feedback Potentiometer, Optical Encoder.

Powerhead Disassembly

Refer to Figure 5-5.

1. For this procedure, the powerhead can be left on the arm and turned upside- down, or removed from the arm and placed upside-down on a padded surface.
2. Unplug and remove the heater from the powerhead. The heater plug may be small phone-type. If so, release clip may be cut back, requiring a small screwdriver or similar tool to release it.
3. Unplug the powerhead cable from the Pedestal Column connector.

4. Remove the four screws from the bottom cover next to the feet. (If the powerhead is on the arm, be careful the top cover doesn't fall after removing the screws.)
5. Remove the powerhead covers. (Slide the bottom cover over the cable.)
6. Turn the powerhead over on the arm or a padded surface.

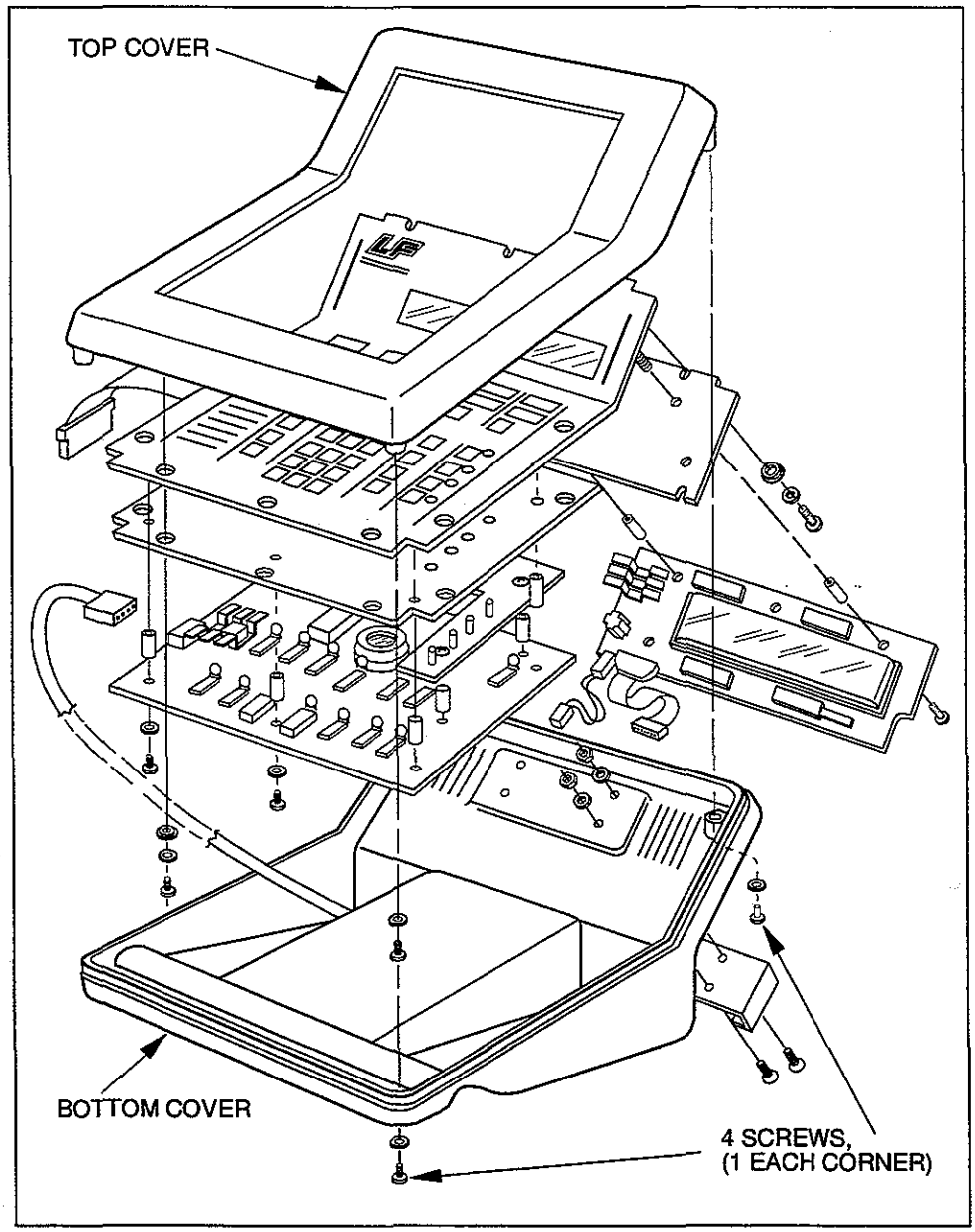


Figure 5-4
Keyboard Console Disassembly

Powerhead Reassembly

Refer to Figure 5-5.

1. Install the powerhead covers on the Head surface. (Slide the bottom cover over the cable.)
2. Install and tighten the four screws to the bottom cover.

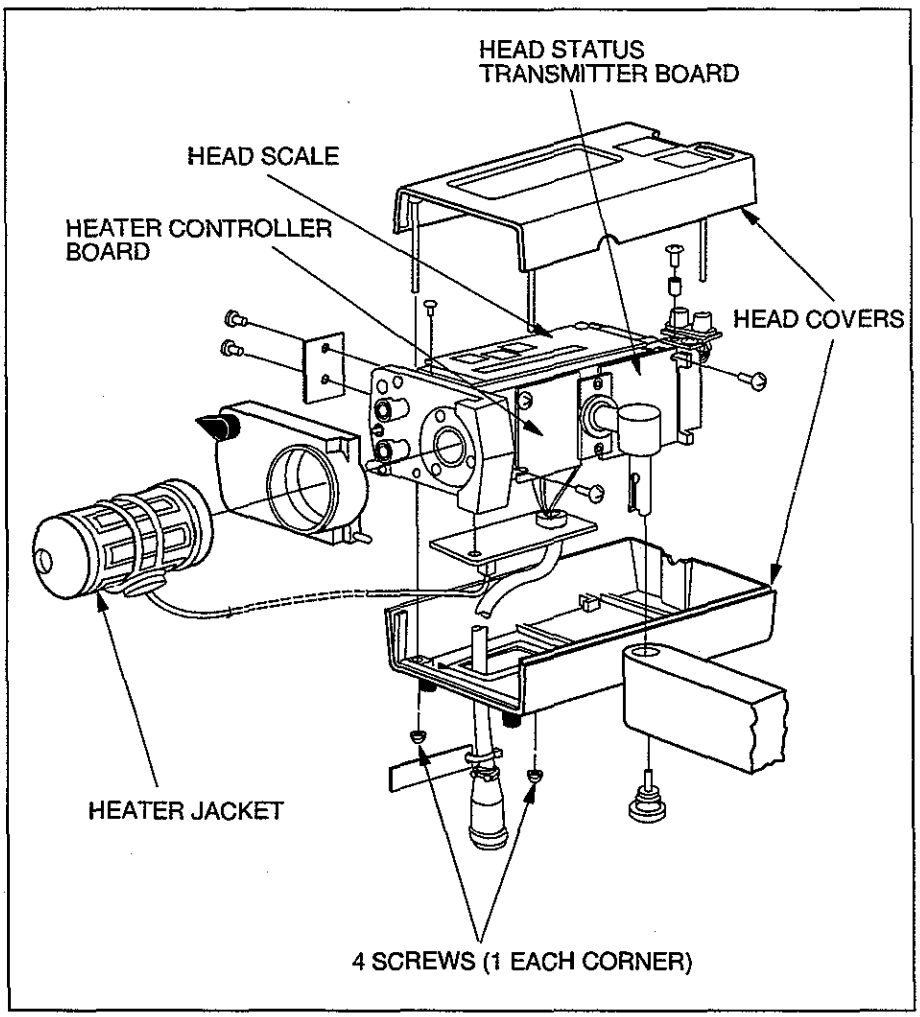


Figure 5-5
Powerhead Disassembly

Head Scale Removal and Replacement

Refer to Figure 5-5.

1. Remove the two screws holding the scale.
2. Unplug the connectors from the scale to the circuit board.
3. Place the new scale on top of powerhead. Line up the two holes.
4. Install (but don't tighten) the two screws to retain the scale.
5. Plug in the connectors from the scale to the circuit board.
6. Calibrate the scale by following the procedure outlined in Chapter 6.

Heater Controller Board Removal and Replacement

Refer to Figure 5-5.

1. Unplug the connectors on the heater controller board.
2. Remove the two screws holding the board to the side of the powerhead.
3. Remove the board from the powerhead.
4. Place the replacement board on the side of the powerhead. Line up the holes in the board with the holes in the powerhead.
5. Install (but don't tighten) the two screws retaining the board.
6. Plug the connectors into the board.
7. Plug the heater into the powerhead.
8. Plug the powerhead cable into its proper connector.
9. Plug in the injector and turn on power.
10. Calibrate the limit switches as described in Chapter 6.

Head Status Transmitter Board Removal and Replacement

Refer to Figure 5-5.

1. Unplug the connectors on the powerhead status transmitter board.
2. Remove the two screws holding the board to the side of the powerhead.
3. Remove the board from the powerhead.
4. Place the replacement board on the side of the powerhead. Line up the slots in the board with the holes in the powerhead.
5. Install (but don't tighten) the two screws retaining the board.
6. Plug the connectors into the board.
7. Plug the powerhead into the Pedestal Column connector.
8. Plug in the injector and turn on power.
9. Calibrate the limit switches as described in Chapter 6.

Feedback Potentiometer Removal and Replacement

Refer to Figure 5-6.

1. Note the wires connected to the pot. Write down the connections.
2. Unsolder the three wires connected to the pot.
3. Remove the pot belt from the drive gear and pot gear. (Remove from the drive gear first.)
4. Remove the pot from the powerhead.
5. Install the replacement pot in the powerhead.
6. Install the three wires removed from the pot in step 2.
7. Before installing the pot belt, calibrate the pot as described in Chapter 6.

Optical Encoder Removal and Replacement

Refer to Figure 5-6.

1. Unplug the connector from the optical encoder to the powerhead status transmitter board.
2. Remove the two screws holding the optical encoder assembly to the powerhead.
3. Remove the optical encoder assembly from the powerhead.
4. Place the replacement optical encoder assembly into the powerhead. Line up the holes in the bracket with the holes in the powerhead.
5. Install (but don't tighten) the two screws retaining the bracket. Be careful that the encoder doesn't touch the chopper wheel.
6. Plug the connector from the optical encoder into the powerhead status transmitter board.
7. Plug the powerhead into the Pedestal Column connector.
8. Plug in the injector and turn on power.
9. Calibrate quadrature as described in Chapter 6.

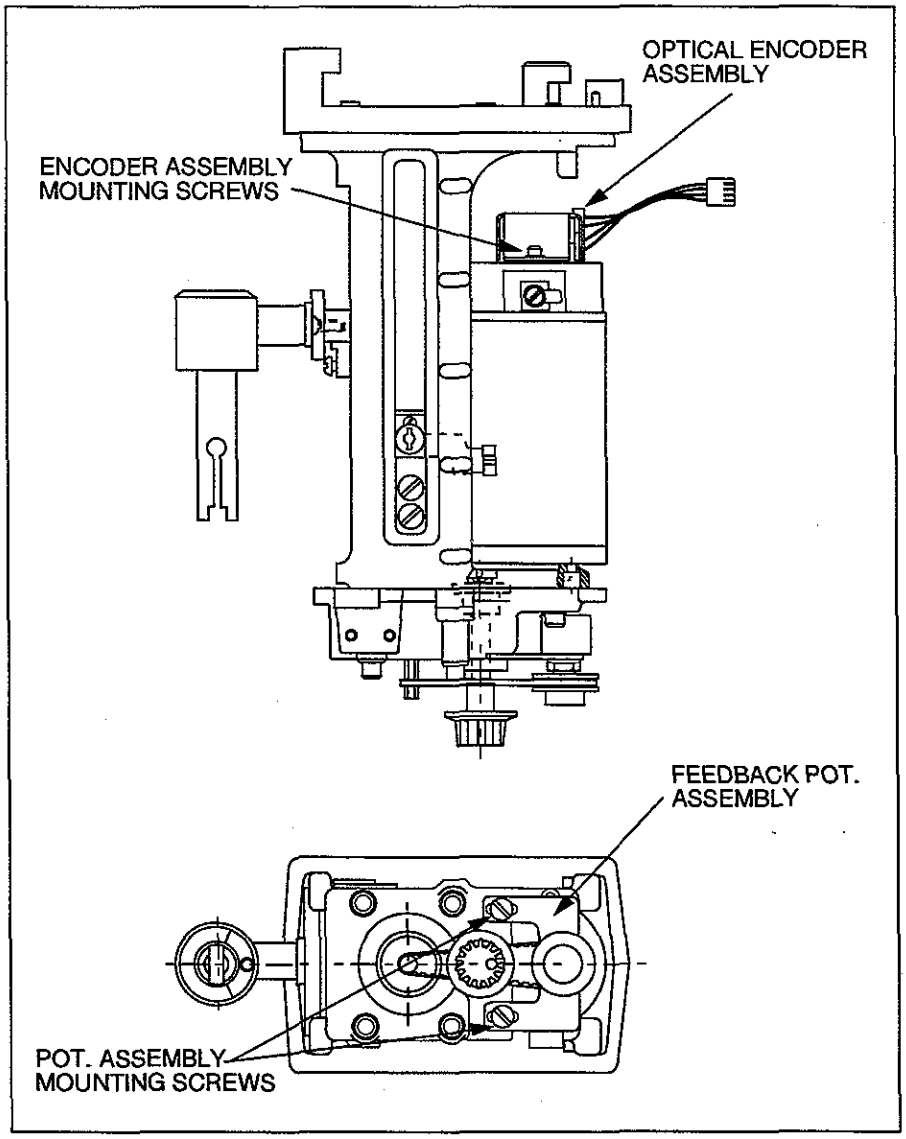


Figure 5-6
Removing/Replacing Feedback Potentiometer &
Optical Encoder Assemblies

6 CALIBRATION

This Chapter contains calibration procedures for the Angiomat 6000 injector.

The Angiomat 6000 Injector has been calibrated in accordance with U.S. Government Regulations prior to leaving the factory. The following procedures contained in this chapter are for field calibration of a unit after troubleshooting or board replacement. If the unit has a problem, use Chapter 5—Troubleshooting, to track down the cause of the problem and repair the unit before attempting any calibration.

This Chapter presumes some familiarity with the operation of the injector, such as loading, setting controls, preparing to inject and injecting. For more details, see the Operator's Manual.

To perform these calibrations, the powerhead or base must be disassembled. For details, see Chapter 5.

TOOLS AND TEST EQUIPMENT

The following tools are required for disassembly and calibration. Each procedure lists the specific tools needed for that procedure.

- Hex (Allen) wrench, 5/32
- Small Screwdriver (1/8 flat blade)
- Medium Screwdriver (1/4 flat blade)
- Small Philips Screwdriver
- Medium Philips Screwdriver

The following equipment is also required for calibration checks and adjustments. Each procedure lists the specific test equipment needed for that procedure .

- Oscilloscope, 50 MHz, dual-trace
- Digital Multimeter
- 14-pin IC Clip
- Jumper
- Pressure Testing Equipment (P/N 600867)
- 150 ml Syringe System

DANGER!
Shock hazard-Be extremely careful when the Angiomat 6000 is open. Lethal voltages are exposed. Be careful not to leave an open system unattended with power plugged in. Disconnect the power cord before removing or replacing boards.

DANGER!
Shock hazard-Line operated servo. Be extremely careful around the servo. It is line operated and not isolated. Lethal voltages are exposed. Be extremely careful when testing or calibrating. Disconnect the power cord before touching any components on the servo board and before removing or placing the servo board.

CALIBRATION SCHEDULE

The calibration procedures given in this Chapter can be classified by two types—powerhead Calibrations and Velocity & Pressure Limit Calibrations. These calibrations must be performed after the unit has been repaired and also should be performed every 12 months for precautionary measures.

POWERHEAD CALIBRATIONS

Calibration procedures for the powerhead include:

- Quadrature
- Tilt Switch
- Jumper Placement for CAL Mode
- Feedback Potentiometer
- Drive Belt Tension
- Limit Switches
- Head Scale
- Press-to-Test Button

The calibrations must be performed in the order in which they are presented.

CAUTION!
Removal of powerhead covers will provide sufficient access to components for calibration. Further mechanical disassembly of the powerhead may cause impaired performance or malfunction.

QUADRATURE TEST AND CALIBRATION

Use this procedure to check and calibrate the optical encoder—the key element in the velocity control loop which sends velocity feedback to the switch.

Items Required

- Dual-Trace Oscilloscope
- Medium Philips Screwdriver (to disassemble powerhead)
- Small Flat Screwdriver (for quadrature adjustment)
- Hex Head Wrench, 5/32"

Set-up

1. Turn off power and disassemble the powerhead (for procedure, see Chapter 5).
2. Set oscilloscope:
   Vertical 2 V/div
   Horizontal 0.2 millisecond/div
3. With the dual-trace scope, monitor pins 10 and 11 of U17 on the Analog Interface Board. See Figure 6-10 and 6-11 for location of U17.
4. Turn on power. Allow 30 seconds to complete power-up diagnostics.

Quadrature Test

1. Fully reverse the ram with the load key.
2. Run the injector with the forward load key. The waveforms should look like those shown in Figure 6-1. If these waveforms are correct, quadrature is properly adjusted.

   If the waveforms are not as shown in Figure 6-1, quadrature should be calibrated. Continue with the following procedure.

Quadrature Calibration Procedure

1. Turn potentiometer P1 on the Encoder Circuit Board fully counter-clockwise. See Figure 6-2 for location of the Encoder Circuit Board.
2. Make coarse adjustment by moving the encoder bracket. See Figure 6-2.
3. Run the injector with the forward load key and monitor the test points. Adjust quadrature by slightly moving the encoder bracket left, right, forward or backward until the waveforms are as close as possible to those shown in Figure 6-1. In most cases movement of only 1/16" is sufficient.
4. Tighten the two screws holding the encoder bracket.
5. Make fine adjustments by turning P1to achieve the waveforms.
6. Repeat the Quadrature Test to ensure the encoder is still properly aligned.

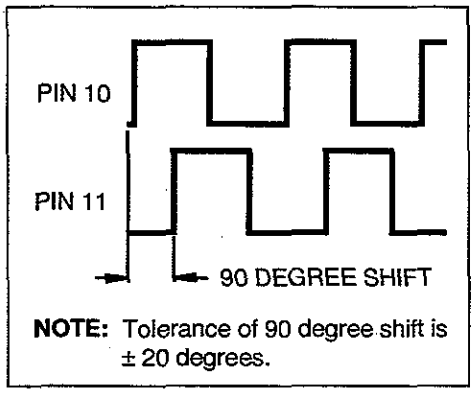


Figure 6-1
Quadrature Waveforms

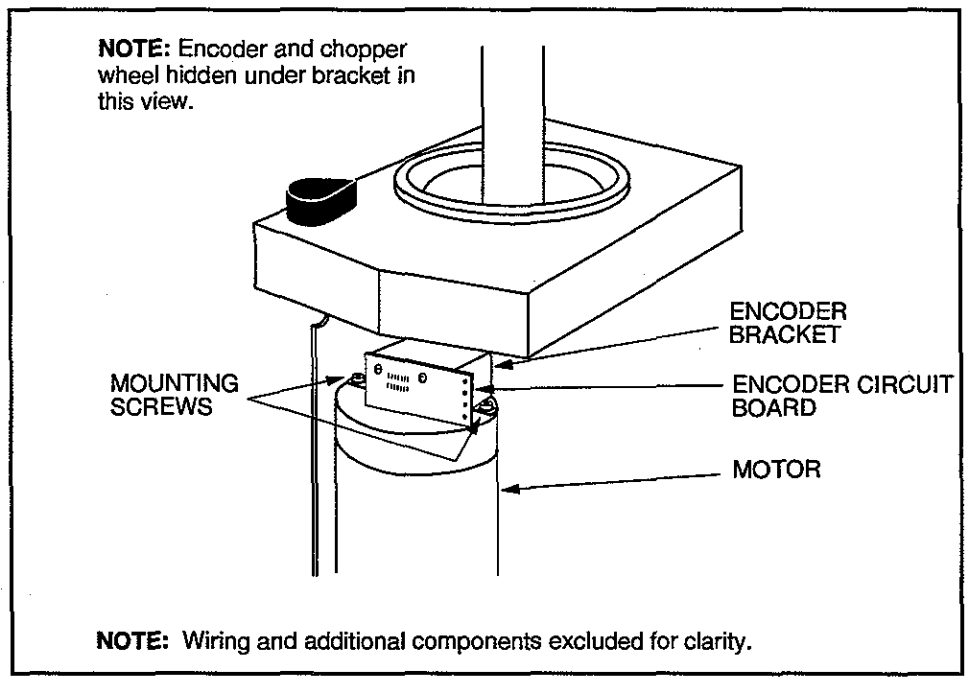

NOTE: Encoder and chopper wheel hidden under bracket in this view.
ENCODER BRACKET
MOUNTING SCREWS
ENCODER CIRCUIT BOARD
MOTOR
NOTE: Wiring and additional components excluded for clarity.

Figure 6-2
Encoder Bracket Adjustment for Quadrature

TILT SWITCH TEST

Use this procedure to check the tilt switch, to see if it is working properly. Follow this procedure to verify a defective tilt switch before replacing it, and to check operation after replacing a tilt switch.

Items Required

- Jumper
- Medium Philips Screwdriver (to disassemble the powerhead)

Set-up

1. Turn off power and disassemble the powerhead (for procedure, see Chapter 7).
2. Install the jumper in the powerhead from J8 pin 2 to the negative side of capacitor C4. See Figure 6-8 for location of J8 and C4.
3. Position powerhead vertically, pointing up.
4. Turn on power. Allow 30 seconds to complete power-up diagnostics.

Procedure

1. Press the special key twice. The system display will state:

   ENTER COMMAND

2. Enter D-E-B then press the Start key.
   (To enter D-E-B: For D, press and hold the No key, then press the 2 key, then release both; for E, press and hold Clear and 2; for B, Clear and 1.)
3. Turn off power, then turn on again. A few seconds after the power-up diagnostics, the System Display will state the following message and all LED's on the control panel will light.

   CHECK LIGHTS PLEASE

4. A few seconds later, this message light will appear:

   POSITION INJECTOR HEAD HORIZONTALLY
   PRESS YES WHEN HORIZONTAL

5. Pivot the powerhead so it is pointing horizontally, then press the Yes/ Enter key. The System Display should return to normal status. If the following message appears, the tilt switch is defective and should be replaced.

   TILT SWITCH ERROR

6. Turn off power, then turn on again (leave powerhead in horizontal position). A few seconds after the power-up diagnostics, the System Display will state the following message and all LED's on the control pattern will light.

   CHECK LIGHTS PLEASE

7. A few seconds later, this message will appear:

   POSITION INJECTOR HEAD VERTICALLY
   PRESS YES WHEN VERTICAL

8. Pivot the powerhead so it is pointing vertically, then press the Yes/ Enter key. The System Display should return to normal status. If the following message appears, the tilt switch is defective and should be replaced.

TILT SWITCH ERROR

9. Press the Special key twice.
10. Enter D-E-B, then press the Start key. **This procedure must be performed to remove the injector from the light and tilt switch checking mode.**
11. Turn off power and remove the jumper in the powerhead.

JUMPER PLACEMENT FOR CAL MODE

1. Turn off power.
2. Install the jumper in the powerhead from J8 pin 2 to the negative side of capacitor C4. See Figure 6-8 for location of J8 and C4.
3. Turn on power. Allow 30 seconds to complete power-up diagnostics.
4. Press the Special Key twice. The System Display will show:

ENTER COMMAND

5. Enter C-A-L (to enter C-A-L: For C, press and hold the Yes/Enter key, then press the 1 key, then release both; for A, press and hold No and 1; for L, Yes/Enter and 4), then press the START key. The System Display will show:

R XX F

XX is a random value. Any value can be display at this time.

FEEDBACK POTENTIOMETER CALIBRATION

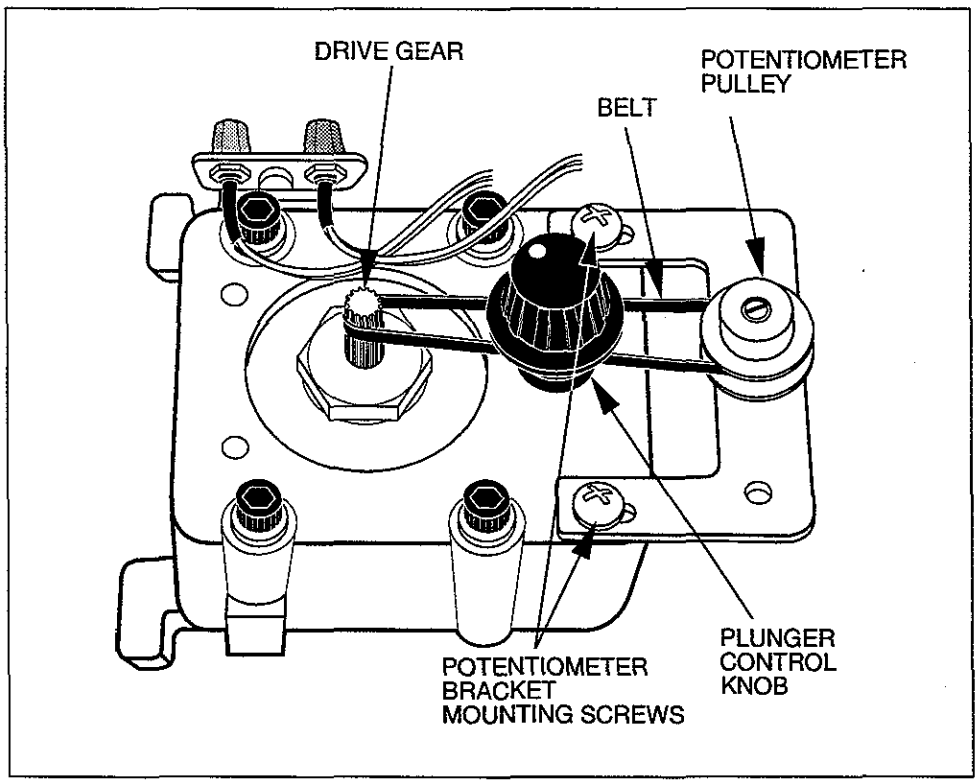


Figure 6-3
Feedback Potentiometer Assembly

Use this procedure to check and calibrate the feedback potentiometer in the powerhead. The powerhead must be in the CAL mode (reference Jumper Placement for CAL Mode—this chapter).

Procedure

1. With the powerhead placed in the CAL mode, adjust the ram so that it is flush with the face plate then press the No key. If the pot is properly calibrated, the System Display will show

   R F2 F

   R F1 F and R F3 F is also acceptable. If any other value appears, proceed to step 2 to calibrate the pot, otherwise proceed to Step 6.
2. Remove the belt from the pot (see Figure 6-3) by sliding the belt off the drive gear and lifting the belt off the pot gear.
3. Repeatedly press the No key while turning the pot. The message on the System Display will change in response. Turn the pot until the message reads the following. The pot is then correctly positioned.

   R F2 F

   R F1 F and R F3 F is also acceptable.

4. Carefully slide the belt over the pot gear and the drive gear without turning the pot gear.
5. Re-check the position: Press the NO key. The message on the System Display should show the following. If not, then return to step 2.

R F2 F

DRIVE BELT TENSION CALIBRATION

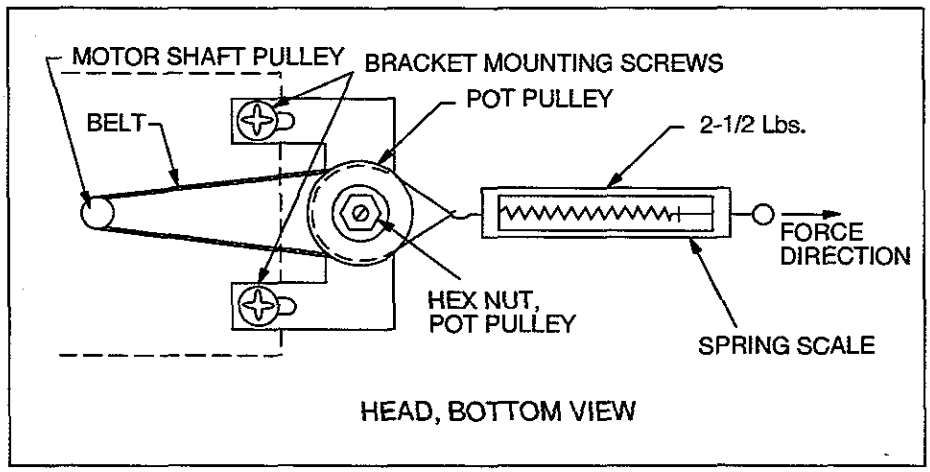


Figure 6-4
Adjusting Drive Belt Tension

Perform the Feedback Potentiometer Calibration before adjusting the Drive Belt Tension. The proper belt tension between the servomotor drive gear and the gear on the feedback potentiometer must be maintained. Use the following procedure to check and adjust the tension.

Procedure

1. Position the powerhead sideways in such a way that the pot mounting bracket is facing downward. See Figure 6-5.
2. Loosen bracket mounting screws if not already loosened.
3. Position the belt around the servo motor shaft and potentiometer pulley.
4. Tie a piece of string around the hex nut that holds the potentiometer on the bracket.
5. Place the other end of the string on a spring scale and apply a 2 1/2 Ib. force. See Figure 6-5.
6. While holding the scale at the 2 1/2 Ib. mark, tighten the bracket mounting screws.
7. The drive belt tension is now at the proper level.
8. Proceed to *Limit Switch Calibration.*

LIMIT SWITCH CALIBRATION

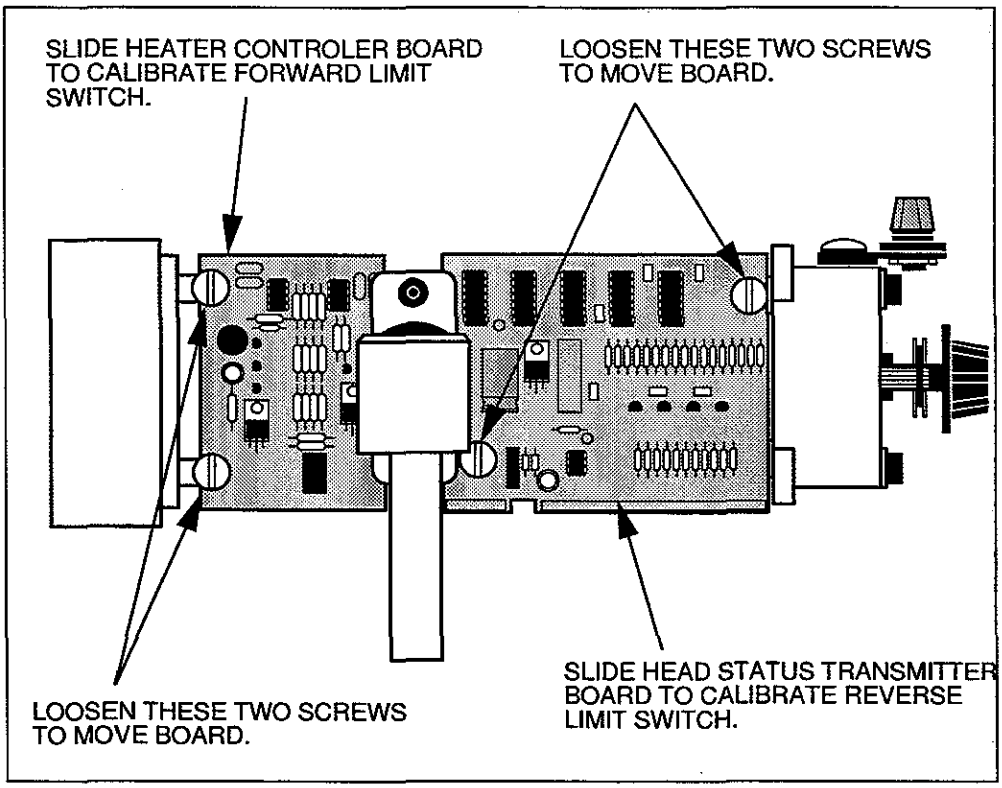

SLIDE HEATER CONTROLER BOARD TO CALIBRATE FORWARD LIMIT SWITCH.
LOOSEN THESE TWO SCREWS TO MOVE BOARD.
LOOSEN THESE TWO SCREWS TO MOVE BOARD.
SLIDE HEAD STATUS TRANSMITTER BOARD TO CALIBRATE REVERSE LIMIT SWITCH.

Figure 6-5
Limit Switch Calibration

The powerhead must still be in the CAL mode.

Optical limit switches are mounted to boards in the powerhead to sense the ram's end-of-travel limits. The position of the limit switches is changed by sliding the boards. Use this procedure to check and calibrate the limit switches.

Reverse Limit Switch Calibration Procedure

1. Position the powerhead horizontally. While repeatedly pressing the No key, turn the piston control knob until the System Display reads

   R EE F

   A transient display of R ED F is acceptable.

   Turn the piston control knob clockwise (from the back) slightly past this point, then turn it back until the display again reads EE. Notice, though, that as EE appears, the R should become underlined.

   If this occurs properly, the reverse limit switch is properly aligned. Continue with step 3 to check the forward limit switch.

   If this does not occur properly, continue with step 2 to calibrate the reverse limit switch.

2. Loosen (but don't remove) the two screws holding the Status Transmitter Board in the powerhead (see Figure 6-5). While repeatedly pressing the No key, turn the piston control knob until the System Display reads:

   R EE F

   Repeatedly press the No key and slide the Status Transmitter Board back until the R is not underlined, then forward until R is underlined. Tighten the board in this position.

Forward Limit Switch Calibration Procedure

1. With the forward load key, run the ram all the way forward. Repeatedly press the No key and turn the piston control knob until the System Display reads

   R 18 F.

   Turn the piston control knob counterclockwise (from the back) slightly past this point, then turn it back until the display again reads 18. Notice, though, that as 18 appears, the F should become underlined. When the F is underlined, release the No key.

   If this occurs properly, the forward limit switch is properly aligned.

   If this does not occur properly, continue with step 2 to calibrate the forward limit switch.

2. Loosen (but don't remove) the two screws holding the Heater Controller Board in the powerhead (see Figure 6-5). Repeatedly press the No key and turn the piston control knob until the System Display reads

   R 18 F.

   Repeatedly press the No key and slide the Heater Controller Board forward until the F is not underlined, then back until the F is underlined. Tighten the board in this position.

3. Turn off power. **Remove the jumper from the powerhead.**

HEAD SCALE CALIBRATION

Use this procedure to check and calibrate the scale on the injector powerhead.

Set-up

1. Power up the unit.
2. Reverse the ram completely with the load key on the powerhead.
3. Open the pressure jacket plate on the front of the powerhead and look at the ram. It should be flush with the face plate of the powerhead. If necessary, turn the Piston Control Knob on the back of the powerhead so the ram is flush with the front plate.
4. Leave the ram in this position to check and calibrate the powerhead scale.

Procedure

1. The pointer should be perpendicular to the scale. If the pointer is not perpendicular, turn the Pointer Adjustment screw located above the scale in order to align the pointer.
2. With the ram set flush with the front plate, the pointer should point to the 150 ml mark ±1 ml. If necessary, loosen the two screws securing the scale and slide it so the pointer is on the 150 ± 1 ml mark. When the scale is properly aligned, tighten the two screws.

PRESS-TO-TEST BUTTON

The powerhead has a "Press-to-Test" button for the heater blanket control circuit. Pressing the button simulates an overheat condition. The sensor then detects the "overheat" condition and sounds the warning buzzer.

A latching/non-latching connector is configured for non-latching on all domestic models. To be assured that the control circuit is functioning properly, perform one of the following tests at least once a month.

Test # 1

1. Press the test button—buzzer sounds.
2. Release button
   A. 220V Injectors: Buzzer goes off—End of Test
   B. 115V Injectors: Buzzer stays on—continue with steps 3—5
3. Turn injector OFF at ON/OFF switch.
4. Press test button and keep it depressed while turning the injector ON again.
5. Keep the test button depressed until buzzer is silent, then release button.

Test # 2

1. Press the test button—buzzer sounds.
2. Release button
   A. 220V Injectors: Buzzer goes off—End of Test
   B. 115V Injectors: Buzzer stays on—continue with steps 3—5
3. Unplug the heater from the socket on the powerhead.
4. Press the test button and keep it depressed while plugging in the Heater.
5. The buzzer should go silent and the button can be released.

VELOCITY AND PRESSURE CALIBRATIONS

Velocity and Pressure calibration procedures include:

- Servo Offset
- Preset Velocity
- Low Speed
- Motor Armature Resistance
- Backup Pressure Limit
- Primary Pressure Limit

The calibrations must be performed in the order in which they are presented.

PRESETTING OF POTENTIOMETERS ON MAIN SERVO CONTROLLER BOARD

In order to begin calibration properly, the potentiometers on the Main Servo Controller board must be preset properly. However, this is only necessary if a new Main Servo Controller Board is being installed. Refer to Figure 6-6 for proper settings.

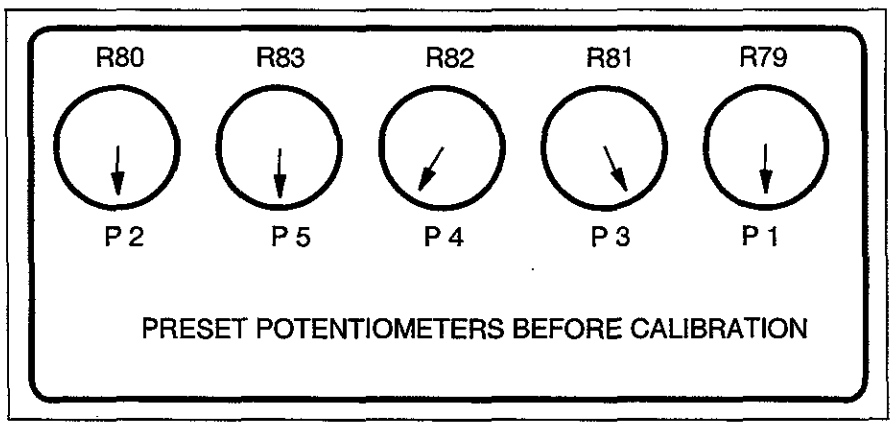


Figure 6-6
Main Servo Controller Board Pre-Calibration Settings

SERVO OFFSET CALIBRATION

Items Required

- Dual-Trace Oscilloscope
- Jumper
- Small Screwdriver

NOTE: *Do not install the syringe to perform this calibration procedure*

Set-up

1. Reverse ram completely.
2. Set oscilloscope:
   Vertical 20 V/div
   Horizontal 20 msec/div
3. Connect oscilloscope to the cathode of D22 on the Servo Bottom and to digital ground.
4. Set injector controls:

Transition Time	0 S
Programmed Flow	0.01 ml/H
Programmed Volume	20 ml
Pressure Limit	1000 PSI

5. Short C3 on the Analog Interface Board 601614 or C16 on the Analog Interface Board 600471 with a jumper. Refer to Figure 6-10 for the location of C3 and Figure 6-11 for the location of C16.

NOTE: *Unit will not power up with jumper installed.*

Procedure

1. Enable and start injection. Adjust P1/R79 on Main Servo Controller board counterclockwise until pulses are visible on scope and motor just starts to move. Refer to Figure 6-10 for the location of P1/R79.
2. Turn P1/R79 clockwise until pulses disappear and motor stops turning.
3. Adjust the pot 5° or 1/32" past the point where the pulses disappear.
4. Disable injection. Leave the jumper in place and proceed to *Preset Velocity Calibration.*

PRESET VELOCITY CALIBRATION

This procedure sets the velocity of the servo motor as it delivers an injection. Before performing this procedure, complete the Servo Offset Calibration.

Items Required

- Jumper
- Small Screwdriver

NOTE: Do not install the syringe to perform this calibration procedure

Set-up

1. Reverse Ram completely.
2. With C3 or C16 still shorted out, set injector controls:

Transition Time	0 S
Programmed Flow	40 ml/S
Programmed Volume	140 ml
Pressure Limit	1000 PSI

Procedure

1. Enable and start the injection. Note the flow rate on the system display at the end of the injection. The rate should read 40.0 ± 0.2 ml/s.
2. If adjustment is needed, adjust P3/R81 and run the injection again; a clockwise turn will increase the flow rate. Refer to Figure 6-10 for the location of P3/R81.
3. **Remove the jumper.**

NOTE: Unit will not power up with jumper installed.

4. Proceed to *Low Speed Calibration.*

LOW SPEED CALIBRATION

This procedure checks and calibrates the velocity signal from the analog interface.

Items Required

- Small Screwdriver

Set-up

1. Reverse Ram completely.
2. Set injector controls:

Transition Time	0 S
Programmed Flow	1 ml/S
Programmed Volume	50 ml
Pressure Limit	1000 PSI

NOTE: Do not install the syringe to perform this calibration procedure

Procedure

1. Enable and start the injection. Note the Injection Duration on the System Display at the end of the injection. It should be between 49.90 and 50.10 seconds.
2. If necessary, adjust R20 on the Analog Interface Board 601614 or R6 on the Analog Interface Board 600471 until the reading is correct. Turn counterclockwise to decrease the time, clockwise to increase the time. Refer to Figures 6-10 and 6-11 for the location of R20 and R6.

MOTOR ARMATURE RESISTANCE CALIBRATION

This procedure checks and calibrates the circuit that balances the motor armature resistance.

Items Required

- Pressure Testing Equipment, P/N 600867
- Digital Multimeter, 300 mV Scale
- 150 ml Syringe
- Small Screwdriver
- 14-pin IC Clip
- Tubing
- Water
- Water Container

Set-up

1. Reverse Ram completely, then turn off power.
2. Attach multimeter test probes: + to U1 pin 7, Main Servo Controller Board, - to Analog Ground located on Analog Board. Use 300 mv scale. Refer to Figure 6-8 for location of U1.
3. Turn on injector power. Allow 30 seconds to complete power- up diagnostics.
4. Set injector controls:

Transition Time	0 S
Programmed Flow	1 ml/S
Programmed Volume	50 ml
Pressure Limit	300 PSI

5. Install a 150 ml and pressure plate and syringe. Install the Pressure Test Equipment on the 150 ml syringe assembly. Refer to Figure 6-7.
6. Properly fill the syringe with water.
7. **Before setting motor stall**, adjust P5/R83 to the 6 o'clock position. Refer to Figure 6-10 for location of P5/R83.

Procedure

1. Remove air from system after gage assembly is installed.
2. Close the valve on the gage completely.
3. Enable and start the programmed injection. Pressure will begin to develop on gage. When pressure reaches the maximum value, a stall condition will develop and last approximately 10 seconds.
4. During the 10 second stall, read the digital voltmeter. Voltage readings should be from 0 to -40 mv. If necessary, adjust P4/R82; to allow the reading to remain a negative value. Refer to Figure 6-10 for location of P4/R82.
5. Program another injection:

Transition Time	0 S
Programmed Flow	1 ml/S
Programmed Volume	50 ml
Pressure Limit	1000 PSI

6. Enable and start the programmed injection and observe the voltage. The voltage reading should be between 0 and -100 mv. If the reading is not within this range, return to Step 5 and repeat the procedure. Correct the condition by adjusting P4/R82.
7. Keep the Pressure Gage Assembly on the unit and proceed to *Pressure Calibration.*

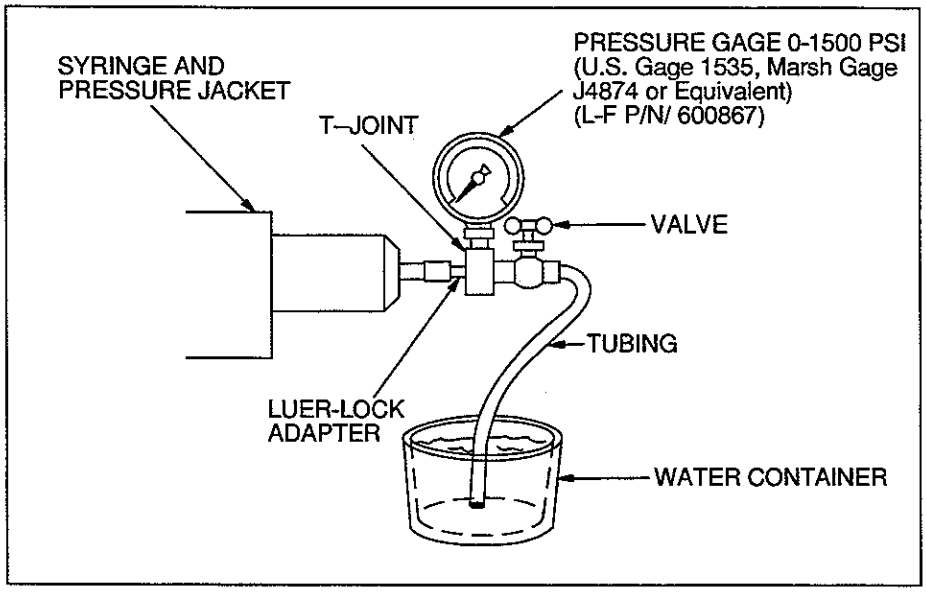


Figure 6-7
Pressure Testing Equipment

PRESSURE CALIBRATION

There are two phases to this procedure. The first phase disables the primary pressure limit, then checks and calibrates the backup pressure circuit. The second phase checks and calibrates the primary pressure limit.

Back-up Pressure Limit Calibration Procedure

1. Properly fill syringe.
2. Set injector controls:

Transition Time	0 S
Programmed Flow	13 ml/S
Programmed Volume	140 ml
Pressure Limit	1000 PSI

3. Enable and start the injection. Adjust the valve until a 750 psi reading is achieved on pressure gauge.
4. Adjust P5/R83 to the 4 o'clock position. Refer to Figure 6-10 for location of P5/R83.
5. Program another injection:

Transition Time	0 S
Programmed Flow	20 ml/S
Programmed Volume	140 ml
Pressure Limit	1000 PSI

6. Enable and deliver the injection. Adjust P2/R80 until gage reads 1100 ±50 psi.

7. After the adjustment and injection are complete, press the ENABLE key. The display should then read: BACKUP PRESSURE LIMIT ENGAGED. DON'T USE FOR CRITICAL PRESSURES. YES TO OVERRIDE.
8. Press the Disable key.
9. Keep the Pressure Gage Assembly on the unit and proceed to *Primary Pressure Limit Calibration Procedure.*

NOTE: If a flow error occurs during the calibration procedure, then P5/R83 has not been adjusted too far counterclockwise. If the backup pressure limit message does not appear, then P5/R83 has been adjusted too far clockwise.

Primary Pressure Limit Calibration Procedure

Use this procedure to check and calibrate the primary pressure. P5/R83 is used to adjust this pressure.

1. Fill syringe without touching the valve on the gage assembly.
2. Set injector controls:

Transition Time	0 S
Programmed Flow	20 ml/S
Programmed Volume	140 ml
Pressure Limit	1000 PSI

3. Enable and start the injection. While delivering injection, adjust P5/R83 until a pressure of 1000 psi is indicated on the gage.
4. Repeat the injection to insure proper adjustment at 1000 psi.

PRESSURE LIMIT ACTIVATION TEST

The following procedure checks for the proper activation of the pressure limit circuits by delivering injections at different programmed pressure limits.

1. Open valve on gage assembly.
2. Set injector controls:

Transition Time	0 S
Programmed Flow	20 ml/S
Programmed Volume	140 ml
Pressure Limit	1000 PSI

3. Enable and start the injection. While delivering injection, slowly close valve until a pressure of 750 psi is indicated on the gage.
4. Without moving the valve setting, refill and run the Injection at the same parameter. At the end of the injection the achieved pressure readout in the system display should read approximately 750 psi and the Pressure Limit LED on the control console should *not* be lit.

5. If the injector performs as indicated in Step 4, repeat Steps 3 and 4 and adjust pressure valve for a gage reading of 1000 psi. At the end of this injection, the achieved pressure readout in the system display should read 1000 psi and the Pressure Limit LED should be lit.

NOTE: *If the Injector does not preform as indicated in step 3,4 and 5, recalibrate the unit for the primary pressure limit.*

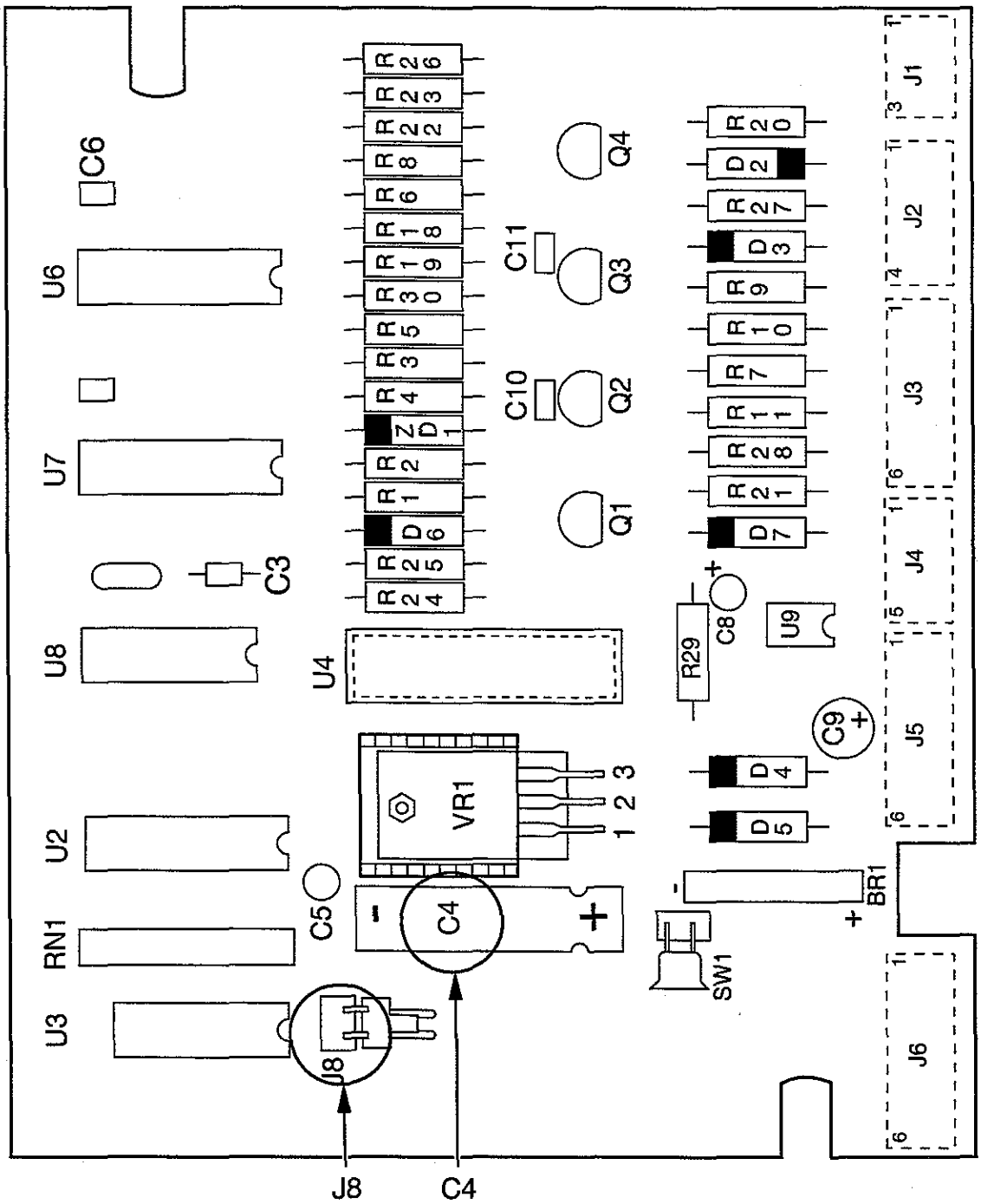


Figure 6-8
Head Status Board—600478

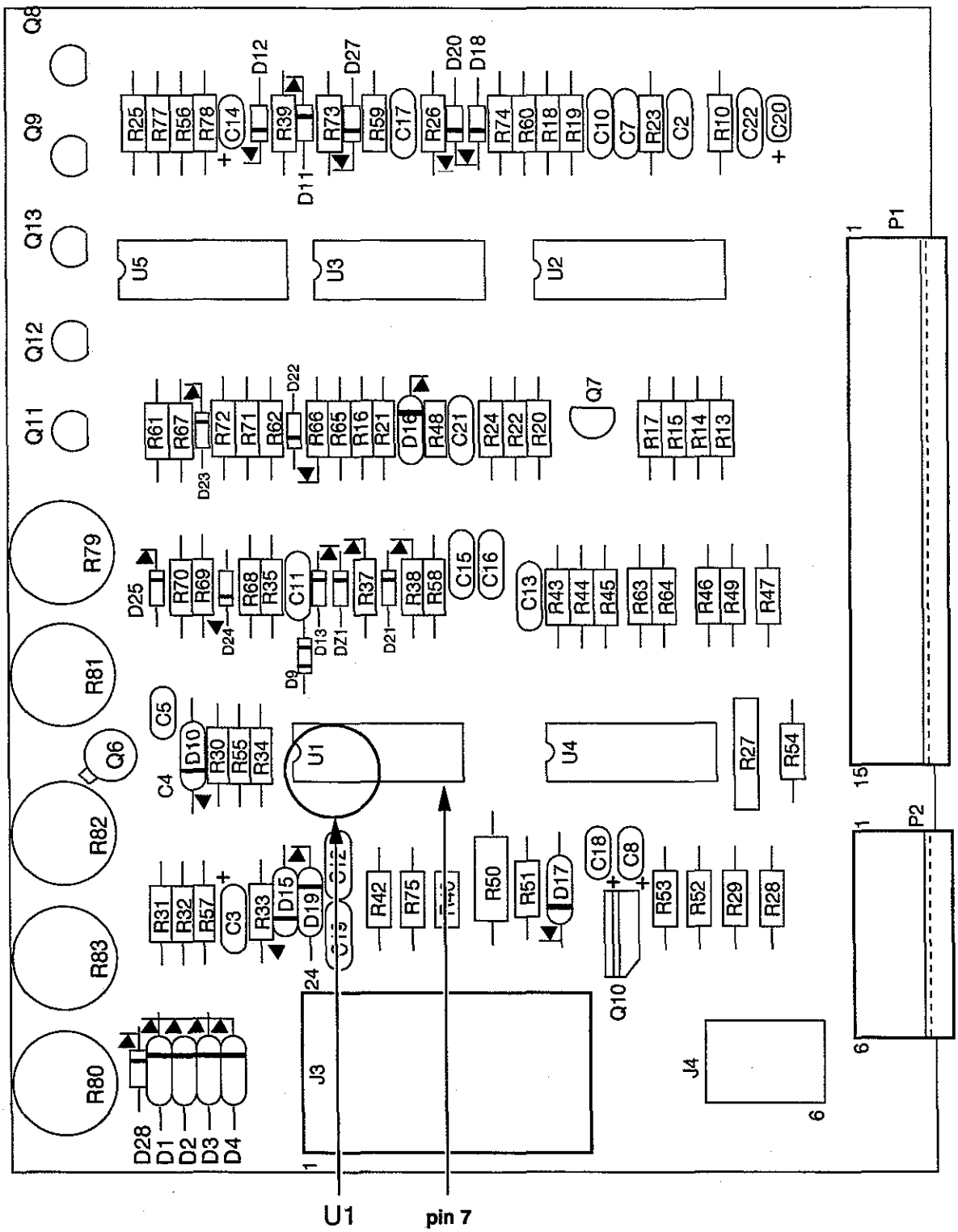


Figure 6-9
Main Servo Controller Board—600472

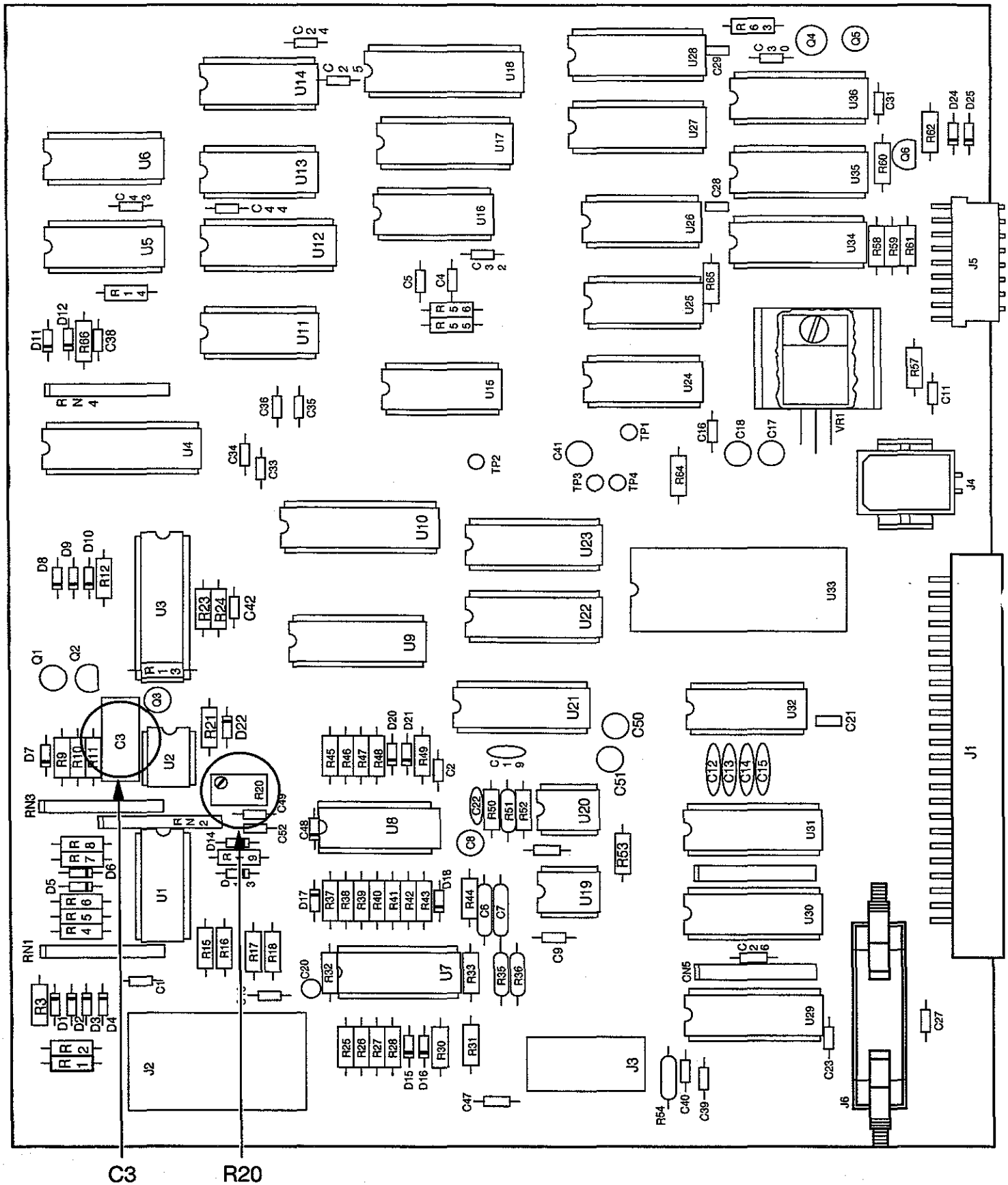


Figure 6-10
Analog Interface Board-601614

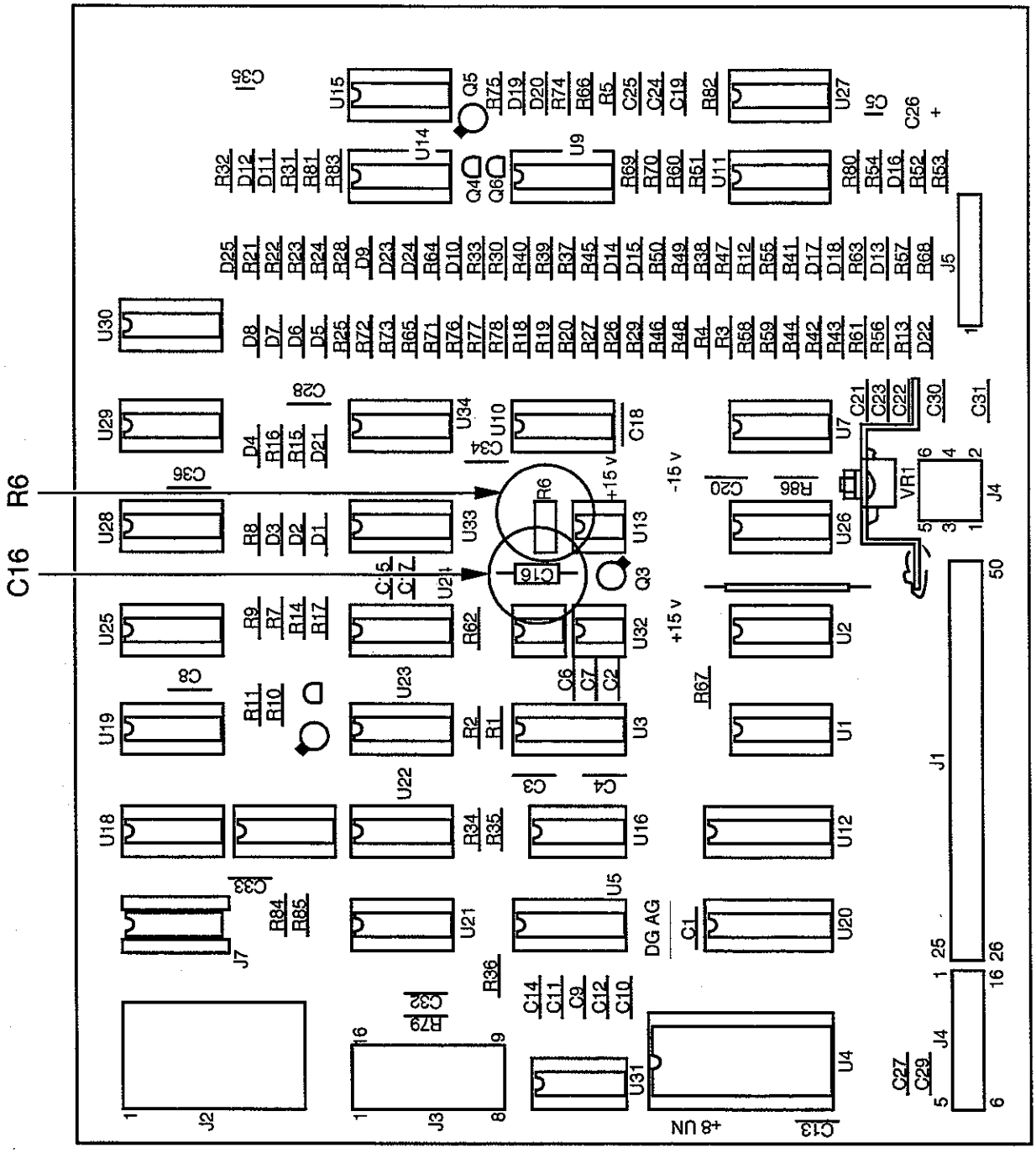


Figure 6-11
Analog Interface Board-600471

7 PREVENTIVE MAINTENANCE

This Chapter contains maintenance procedures for the Angiomat 6000 injector. Guidelines for periodic inspections, testing, cleaning and lubrication are included. Information about assembly and disassembly of the unit is contained in Chapter 5.

A checklist is included in the front pocket of this manual. Fill in the necessary information on a copy of the checklist. File the checklist according to the Serial Number or Hospital in order to maintain a Preventive Maintenance history of the unit.

DANGER! SHOCK HAZARD.
Be extremely careful when the Angiomat 6000 is open. Lethal voltages are exposed. Be careful not to leave an open system unattended with power plugged in. DISCONNECT THE POWER CORD BEFORE DISASSEMBLING THE SYSTEM, AND BEFORE REMOVING OR REPLACING BOARDS.

DANGER ! SHOCK HAZARD—LINE OPERATED SERVO.
Be extremely careful around the servo. It is line operated and not isolated. Lethal voltages are exposed. DISCONNECT THE POWER CORD BEFORE TOUCHING ANY COMPONENTS ON THE SERVO BOARD, AND BEFORE REMOVING OR REPLACING THE SERVO BOARD.

CAUTION!
Disconnect any external equipment from the Angiomat 6000 before any disassembly

QUALIFICATIONS

Preventive Maintenance on any unit must be performed by a Qualified Technician who is completely familiar with the use and operation of the Injector, trained by a Liebel-Flarsheim instructor in the area of preventive maintenance for the Injector and familiar with the content of the Operator's manual and the Installation and Service manual.

MAINTENANCE SCHEDULE

Preventive Maintenance should be performed at least once a year. However, an injector with High or Medium usage should have Preventive Maintenance performed in accordance with the following table.

Injections per Day	Maintenance Schedule
High Usage: 4 or more	every 3 months
Medium Usage: Up to 3	every 6 months

POWERHEAD

VISUAL INSPECTION

1. Turn on the injector. With the load switch, fully reverse the syringe plunger. Turn off power. If there is a syringe in the pressure jacket, remove it and discard.
2. Inspect the pressure jacket. If it is cracked, crazed, scratched or opaque, replace it. As a preventive measure, replace the pressure jacket once a year.

CAUTION!
Syringe pressure jackets must withstand pressures generated during injection delivery. Defective jackets may shatter or explode under these conditions. Always inspect pressure jacket closely before using injector. Rotate the pressure jacket while viewing all areas; look for stress cracks (around the front or at the shoulder area), discard any pressure jacket exhibiting signs of stress, crazing lines or cracks. The use of such parts may cause injury and/or an aborted injection.

3. Inspect the ram, seals and heater connector to ensure they are free from dried contrast. If necessary, clean as directed in the section *Cleaning and Lubrication.*
4. Check the syringe clip for proper operation. It should not be loose or otherwise damaged. The rubber balls should not be loose or missing and the assembly should have proper lubrication in order to rotate freely.
5. Check the heater and its cable for cuts, nicks and crimping.
6. Check the powerhead connector for cracks, broken or protruding pins. Be sure the strain relief bushings on the connector and on the underside of the powerhead firmly secure the cable.
7. Check the powerhead cable for cuts, nicks and crimping.

OPERATIONAL CHECK

1. Check the powerhead arm and the powerhead pivot movement (if applicable). Adjust as necessary.

2. Turn on the injector. Check the operation of the powerhead keys. Make sure the keys are operating freely and not sticking.
3. Check operation of the Heater Test key. Refer to Chapter 6—Calibration for information on the use of this key.
4. Check that the ram correctly picks up the syringe plunger. Also check for unusual powerhead noise while running the ram.
5. Check operation of the pressure jacket plate, knob and latches. Open and close the plate. It should operate smoothly without interference or binding. Check for contrast build up. If necessary, clean as directed in the section *Cleaning and Lubrication.*
6. Check the syringe size LED indicators by installing both a 150 and a 260 ml face plate.
7. Check the "Injecting" and the "Enabled" lights on the powerhead by running a mock injection.

KEYBOARD CONSOLE

VISUAL INSPECTION

1. Check the keyboard console cable for cuts, nicks, and crimping.
2. Check the keyboard console connector for cracks, broken or protruding pins. Be sure the strain relief bushings on the connector and on the underside of the keyboard console are firmly securing the cable.
3. Check the assembly for damage, interference, loose hardware and sticking keys.

OPERATIONAL CHECK

1. Turn on the injector. Check all pixels and LED's for proper operation during power-up sequence.
2. Check that the Start key and Remote Start switch is operating properly and not sticking.
3. Check all displayed characters for clear and steady operation.

For the following steps, refer to the operator's manual for further information.

4. Check with hospital personnel to ensure the Preferred Injection feature is operating properly.
5. Check the operation of the Save/Enter Name key by saving the parameters of a mock injection.
6. Check the operation of the Delete key by deleting the previously saved injection.
7. Check that the "Required Fill Sequence" message appears during the enabling of a mock injection.
8. Check the operation of the Units key by checking the Units available for Programmed Flow and Pressure Limit.

9. Enable and run a mock injection for Multiple Deliveries. Check that the Injection Duration, Transition Time, and Injection Delay values are correct according to the delivered mock injection.
10. Enable and run a Multiphasic Injection. Check that the Injection Duration, Transition Time, and Injection Delay values are correct according to the delivered mock injection.
11. Check the operation of the New Patient key. Volume delivered will reset to zero.
12. Check the ECG (optional) function for proper operation. Refer to Chapter 4 of the Operator's Manual for proper signal quality.

PEDESTAL BASE/ELECTRONICS CABINET

VISUAL INSPECTION

DANGER!
Be sure that the power cord is unplugged before proceeding. Lethal voltages are exposed when the power cord is plugged in and the injector is disabled.

1. Check the power cord for cuts, nicks, and crimping. Be sure the strain relief is firmly securing the cable. It should withstand a 35-lb. straight pull.
2. Check the start cord for cuts nicks, and crimping. Be sure the strain relief is firmly securing the cable.
3. Check optional and external cables for cuts, nicks, and crimping.
4. Check all connectors to be sure they are firmly securing their cables. Remove connections and check for broken or protruding pins.
5. Check that the hub and handle bar are secure. Tighten if necessary.
6. Check that the Pedestal Base or Electronics Cabinet cover is secure.
7. Check casters for ease of movement (if applicable).

ELECTRICAL CHECKS

LEAKAGE AND GROUND CONTINUITY

1. Check the electrical leakage with a leakage meter, or use an AC voltmeter with the attenuation network shown in Figure 7-1. Check the leakage through the power cord ground with ground open. The leakage should be less than 300 microamperes for U.L. listed Models (domestic—UL2601) and less than 500 microamperes (export—IEC 601-1) for all others. If higher, check for the cause and repair.

WARNING!
If system leakage remains above 300 or 500 microamperes (115 Vac is specified at 300 microamperes and 220 Vac is specified at 500 microamperes), do not use the injector as it may be a shock risk for the operator. Contact an authorized service representative.

2. Disconnect the leakage test equipment.
3. Check the ground continuity as follows: Unplug the power cord. Using an ohmmeter, verify continuity between exposed metal parts of the powerhead and the ground pin on the power plug.

DANGER!
If ground continuity is nonexistent, do not use the injector, contact an authorized service representative. Failure to follow this instruction can result in serious injury.

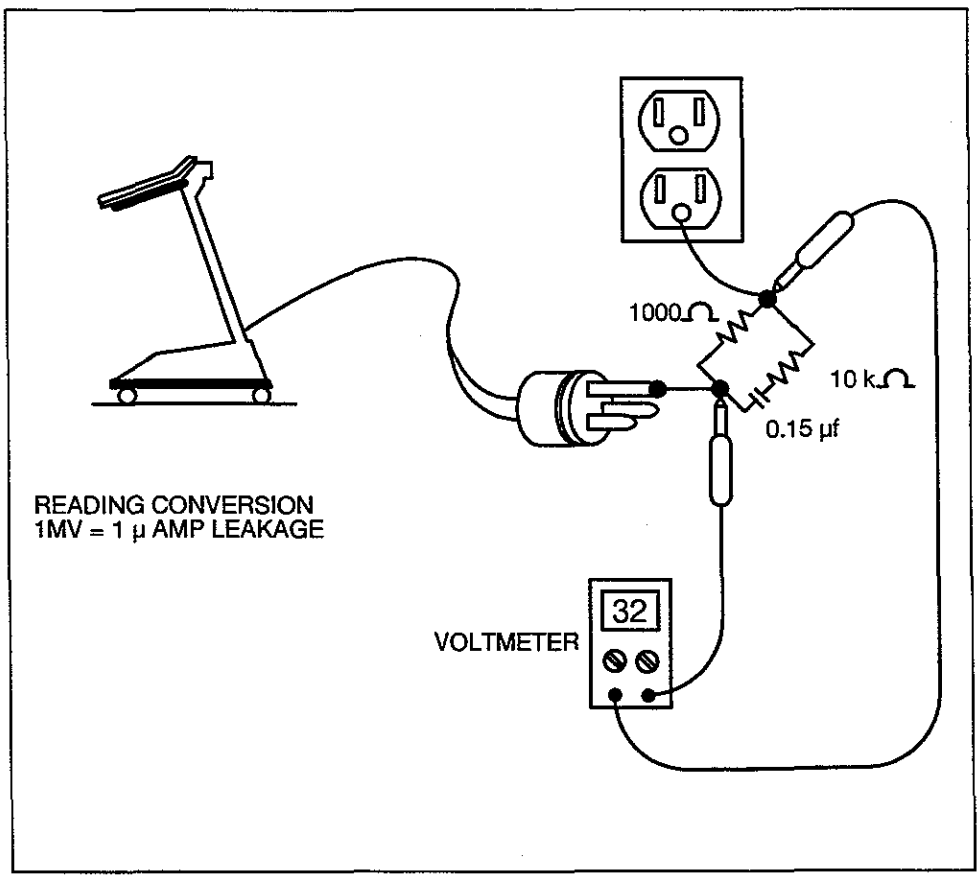


Figure 7-1
Leakage Test Set-Up

POWER SUPPLIES

1. Access the Analog Interface Board and Servo Controller Board. Refer to Chapter 6—Troubleshooting, for more information about disassembly.
2. Refer to Figure 7-2 and 7-3. Check the following voltage supplies:

   - Check Ground. (TP1 on the Analog Interface Board)
   - Check + 5 volt supply. (TP2 on the Analog Interface Board)
   - Check + 8.5 volt supply. (VR1 pin 1 on the Analog Interface Board)
   - Check + 15 volt supply. (TP3 on the Analog Interface Board)
   - Check - 15 volt supply. (TP4 on the Analog Interface Board)
   - Check + 36 volt supply. (P1 pin 1 on the Main Servo Controller Board)

CALIBRATION CHECKS

ADJUSTMENTS

1. Perform a mock injection with a delivery speed of 40 ml/s. If an error occurs, perform the Quadrature Test and Calibration sequence from Chapter 6.
2. Perform a mock Fill Sequence— 1.) Run the plunger to zero 2.) Move the powerhead to the vertical position 3.) Retract the plunger back into the powerhead as though the syringe was being filled. Enable an injection. Ensure that the "Required Fill Sequence" message does not appear. If the message appears, perform the Tilt Switch Test from Chapter 6.
3. Run the Ram to the empty position. The pointer on the Head Scale should read zero ml. Run the ram to the fully loaded position. The pointer on the Head Scale should read 150/260 ml. If needed adjust the Head Scale in accordance with the instructions outlined in Chapter 6—Calibration.

CALIBRATIONS

To insure that the major functions are operating properly, perform the following calibration procedures. The instructions for these procedures are located in Chapter 6—Calibration.

- Servo Offset Adjustment
- Velocity Calibration
- Low Speed Circuit
- Backup Pressure Limit
- Primary Pressure Limit

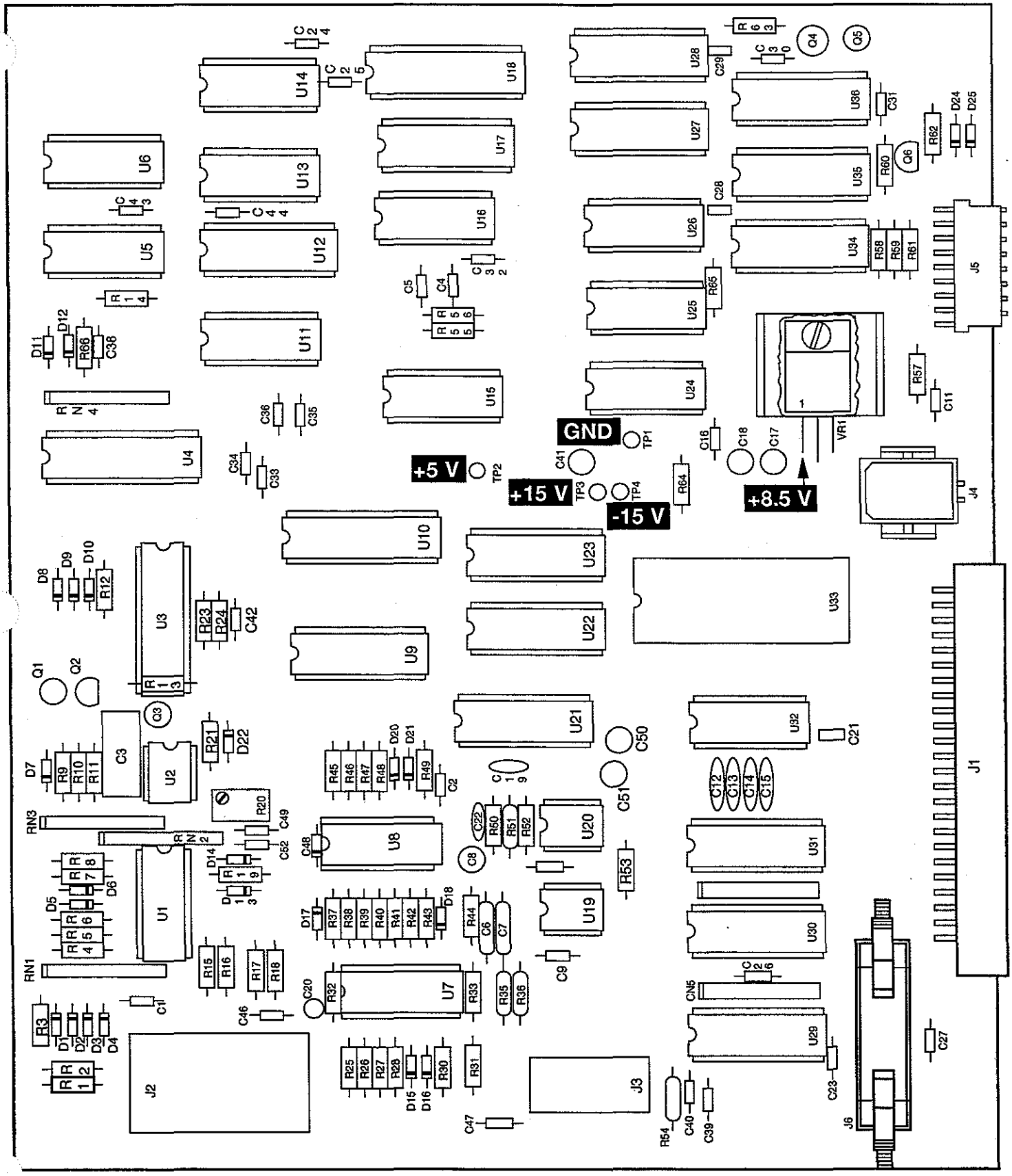


Figure 7-2
Analog Interface Board (601614)

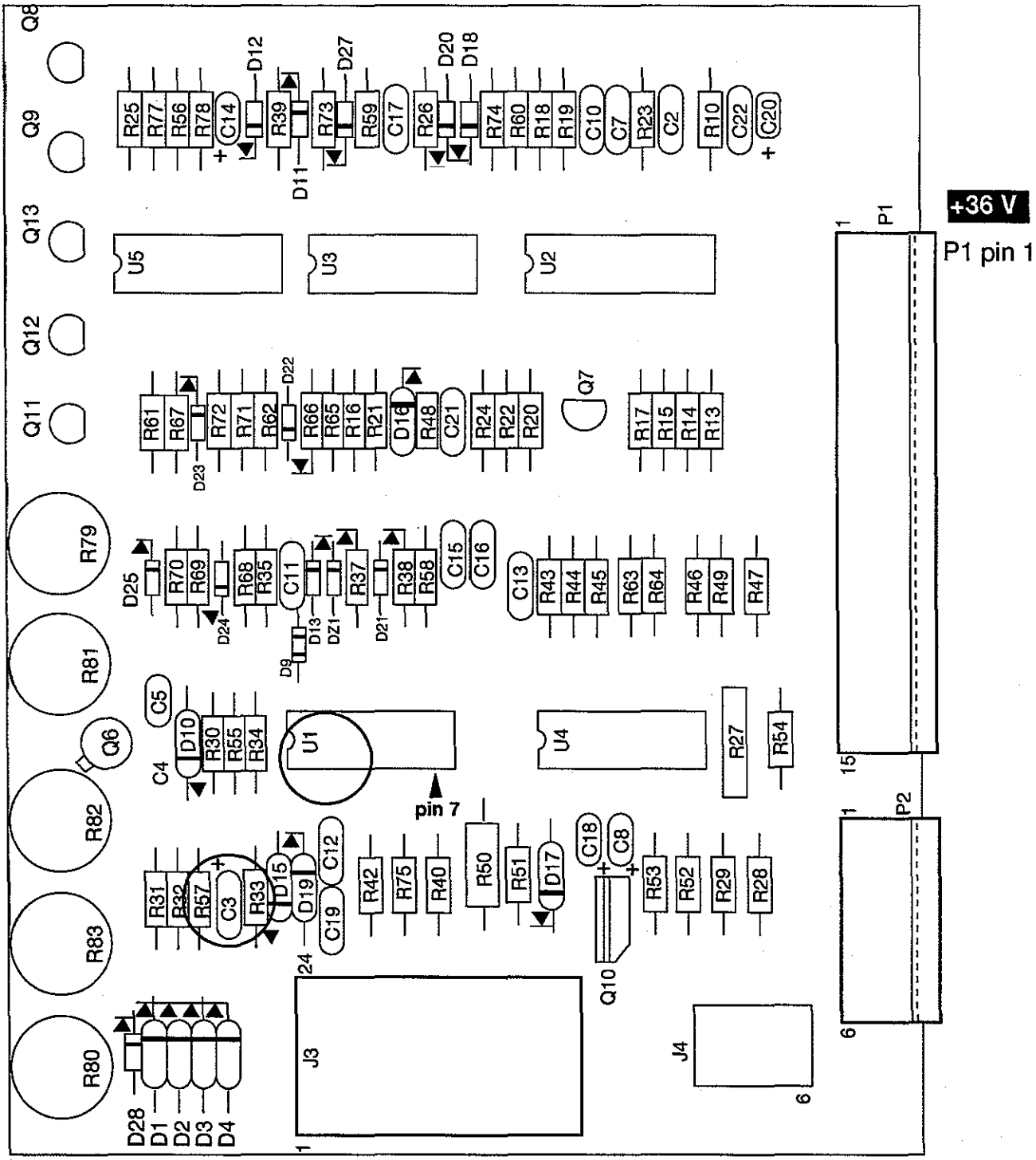


Figure 7-3
Servo Controller (600472)

CLEANING AND LUBRICATION

DANGER!
Be sure that the power cord is unplugged before proceeding Lethal voltages are exposed if the power cord is plugged in and the injector is disassembled.

1. Check the powerhead, keyboard console, and pedestal base and column for spilled contrast medium (dried white deposits). To remove these deposits, carefully wipe off with warm water. Thoroughly dry all parts. Check the syringe plate for dried contrast medium. Soak plate in warm water to remove contrast medium. If knob on plate becomes hard to turn, soak plate for several hours in warm water.

CAUTION!
Do not use excessive water. Do not soak or immerse any components (except for syringe plate) to remove contrast medium. Be sure that the components are completely dry before re-assembling and turning on power. Gentle heat may be applied (from a heat gun or blow dryer), but be careful not to heat the circuit boards or components. Excessive heat will damage electrical components.

2. Lightly lubricate the latches and knob mechanism on the pressure jacket plate. Use a light grease. Open and close the plate several times to distribute the lubricant, then wipe off the excess.
3. Carefully lubricate the arm as follows: Using a spray lubricant , spray around the hole where the arm is mounted to the stand to lubricate the arm's internal mechanism. Move the arm through its range of motion several times to distribute the lubrication, then wipe off the excess.
4. Lightly lubricate the four casters with a spray lubricant or light machine oil (just a drop on each caster).

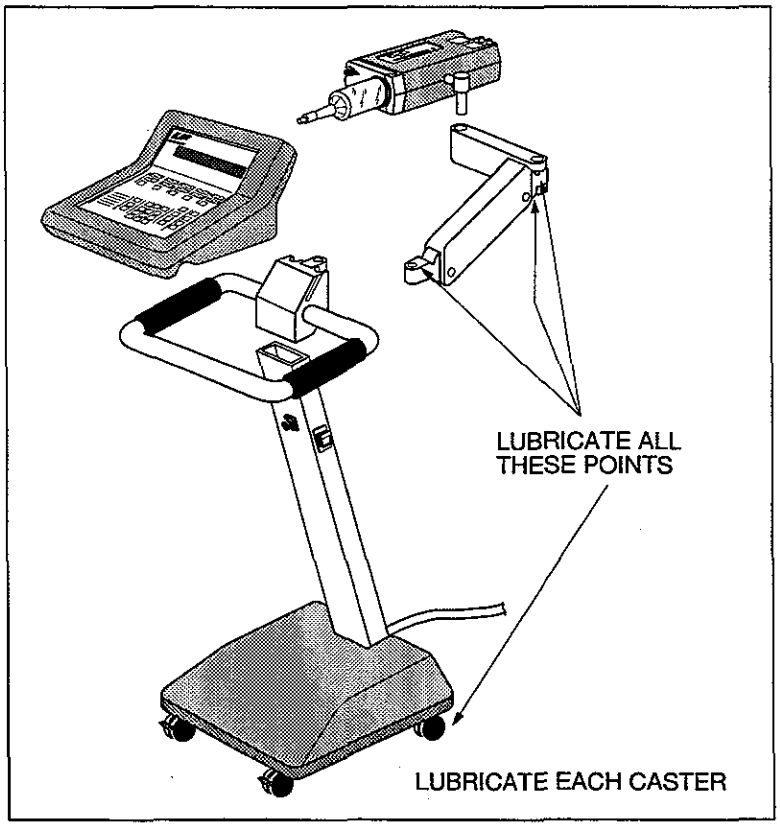


Figure 7-4
Lubrication Points

CUSTOMER INTERFACE

Answer all customer questions regarding operation or use of the equipment. Discuss any areas of concern the customer may have about the unit.

8 GLOSSARY

The abbreviations and acronyms included in this glossary appear in the Angiomat 6000 display when various diagnostic routines and calibration procedures are performed and on schematics and block diagrams.

Abbreviation/Acronym	Definition
AFLOW	Actual Flow
APRESS	Actual Pressure
BACKLIM	Back Pressure Limit
BUFFER D.S.	Buffer Data Storage
COMMEN	Command Enable
CUR SENSE	Current Sense
DFLOW	Desired Flow
DPRESS	Desired Pressure
EN LIGHT	Enable Light
EOC	End of Command
FCCOMM	Film Changer Command
FCRELAY	Film Changer Relay
FCSTART	Film Changer Start
FDIFF	Flow Difference
FWD BUT	Forward Button
FWD PULSE	Forward Pulse
FWD-REV	Forward - Reverse
HCLK	Head Clock
HDAT	Head Data
INJ LIGHT	Inject Light
INJSTRT	Injector Start
MOTOR CUR	Motor Current
PBCOMM	Push Button Command
PBSTART	Push Button Start
PHASE 1	Quadrature 1
PHASE 2	Quadrature 2
PPI	Pre-Programmed Injections
PRESSLIM	Pressure Limit
PWFAIL	Power Fail
PWM	Pulse Width Modulator
READ A/D	Read Analog to Digital
READ ERRL	Read Error Latch
RDSERT	Read Servo Status
REM START	Remote Start
RESERR	Reverse Error
REV BUT	Reverse Button

Abbreviation/Acronym	Definition
REVR	Reverse
REVREL	Reverse Relay
RSTART	Reverse Start
SERVDEN	Servo Disengage
SERVO EN	Servo Enable
SR CLOSED	Safe Relay Closed
SSTART	Start Start
SWAT SAFE	Swat Pulse to Safe Relay
VELCORR	Velocity Correction
WDGSWT	Watchdog Swat Pulse
WRITE A/D	Write Analog to Digital
WRITE START	Write Start

9 SCHEMATICS

The following schematic representations are to be used for reference when reviewing Chapter 4—*Description of Operation.*

WIRING DIAGRAM, POWERHEAD—115V 601421
POWERHEAD KEYBOARD 601430
HEAD STATUS TRANSMITTER 600478
OPTICAL ENCODER 600479
HEATER CONTROLLER 600829
WIRING DIAGRAM, PEDESTAL—115V 600941
WIRING DIAGRAM, PEDESTAL—220V 600939
WIRING DIAGRAM, RACK MOUNT—115V 600943
SERVO BOTTOM 600803
SERVO TOP—115V 600502
SERVO TOP—220 600473
SERVO CONTROLLER 600472
MAIN PROCESSOR 601615
ANALOG INTERFACE 601614
POWER SUPPLY 600487
UNIVERSAL INTERFACE—115V 601115
UNIVERSAL INTERFACE—220V 600868
ECG TRIGGER 600482

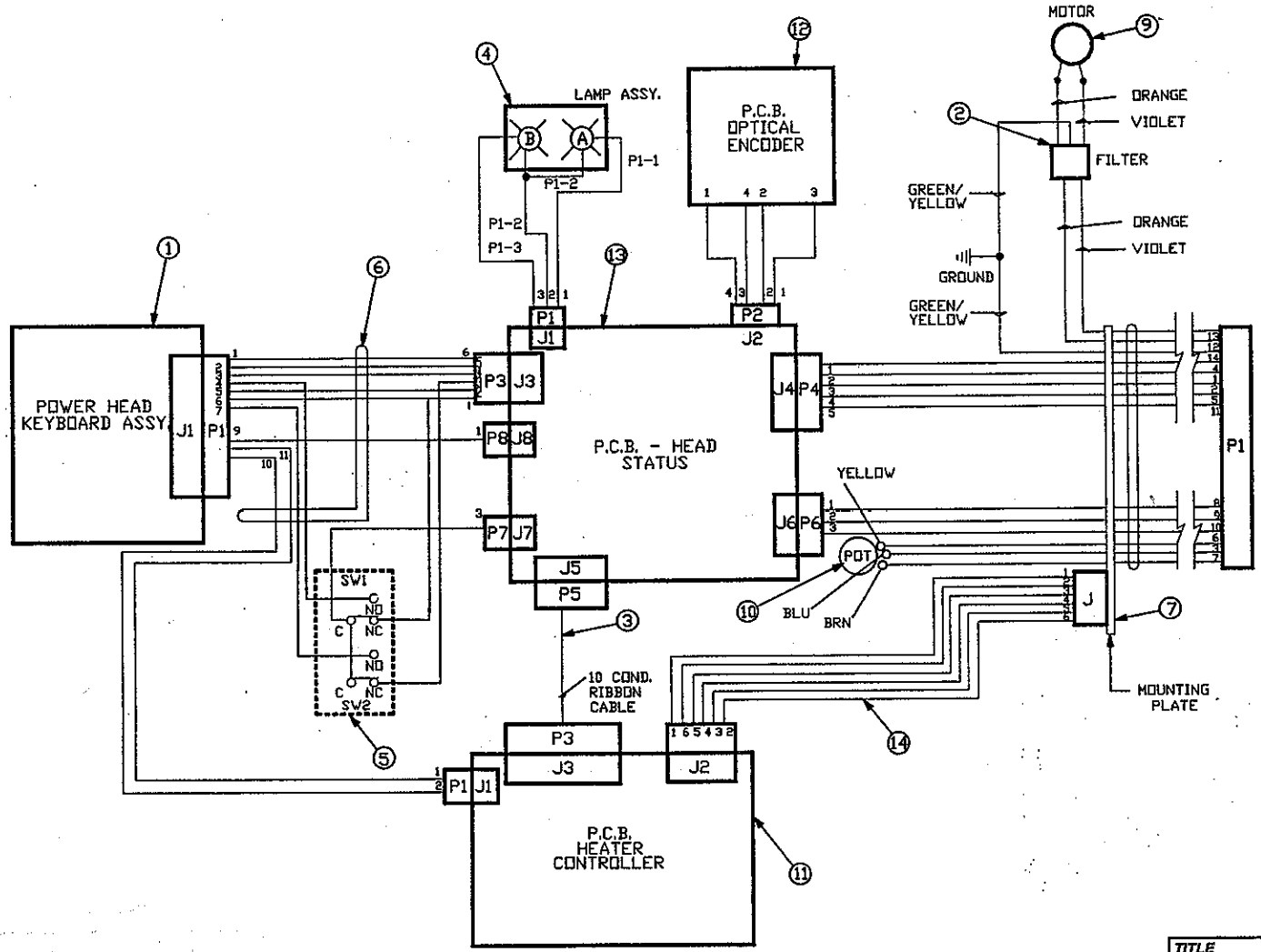


Figure 9-1

TITLE		
WIRING DIAGRAM, POWERHEAD		
DATE	*NUMBER*	*REV*
7/24/92	601421	—

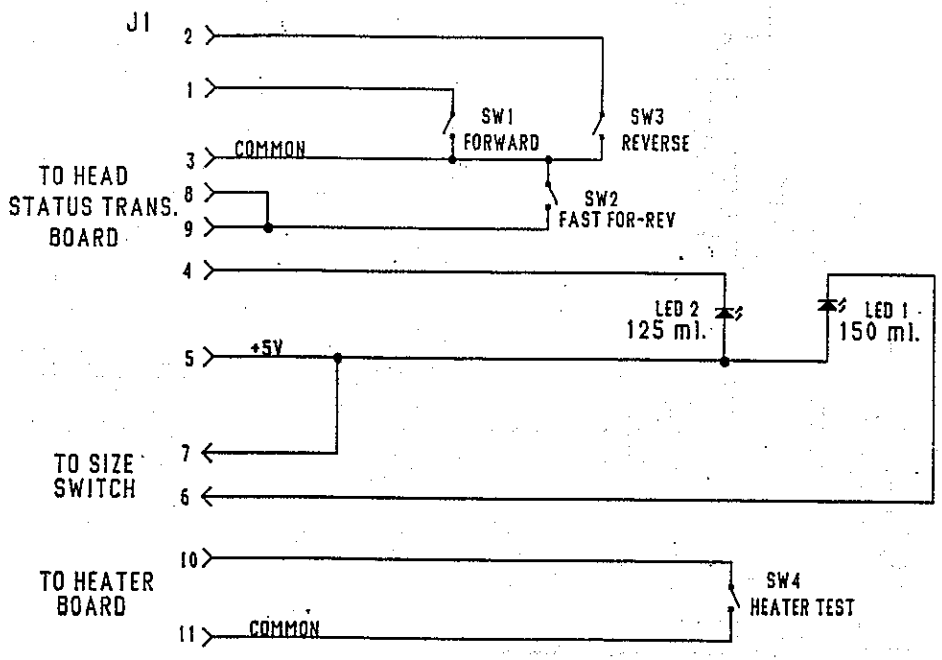
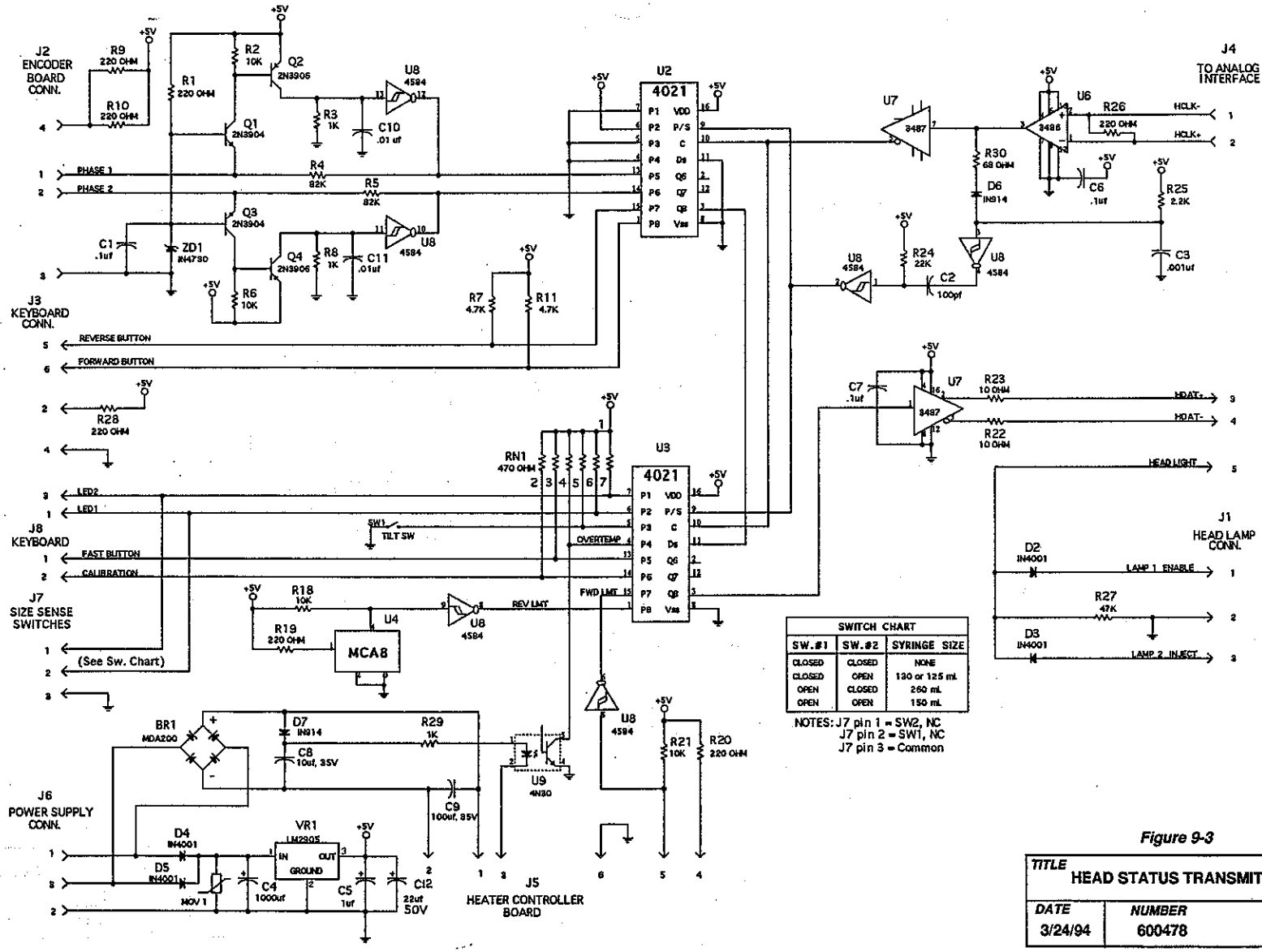


Figure 9-2

TITLE		
POWERHEAD KEYBOARD		
DATE	NUMBER	REV
11/1/93	601430	A

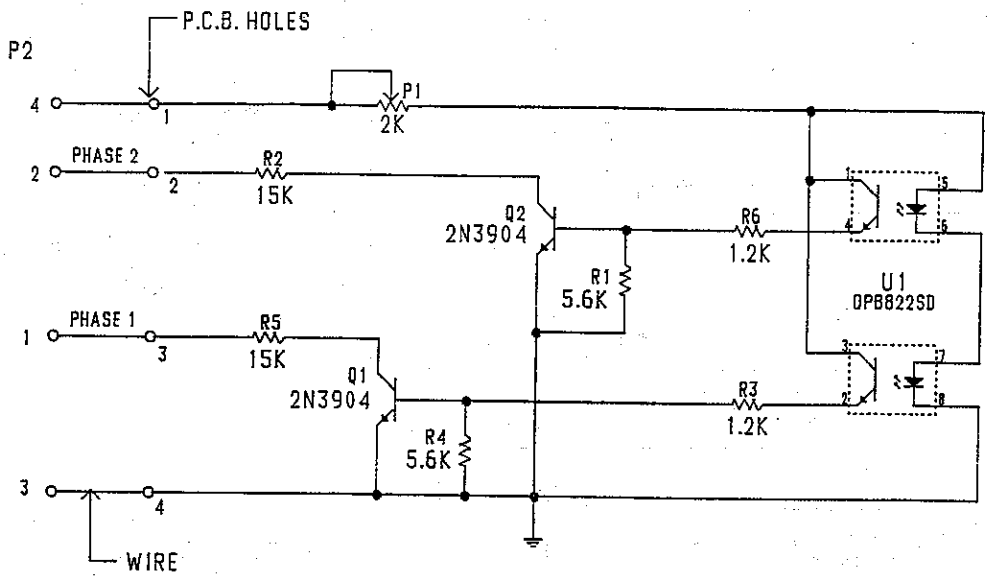


SWITCH CHART		
SW.#1	SW.#2	SYRINGE SIZE
CLOSED	CLOSED	NONE
CLOSED	OPEN	130 or 125 mL
OPEN	CLOSED	260 mL
OPEN	OPEN	150 mL

NOTES: J7 pin 1 = SW2, NC
J7 pin 2 = SW1, NC
J7 pin 3 = Common

Figure 9-3

TITLE		
HEAD STATUS TRANSMITTER		
DATE	*NUMBER*	*REV*
3/24/94	600478	J



NOTE: Connector P2 wires are directly soldered to the P.C.B. at the numbered board holes designated.

Figure 9-4

TITLE		
OPTICAL ENCODER		
DATE	NUMBER	REV
7/12/91	600479	G

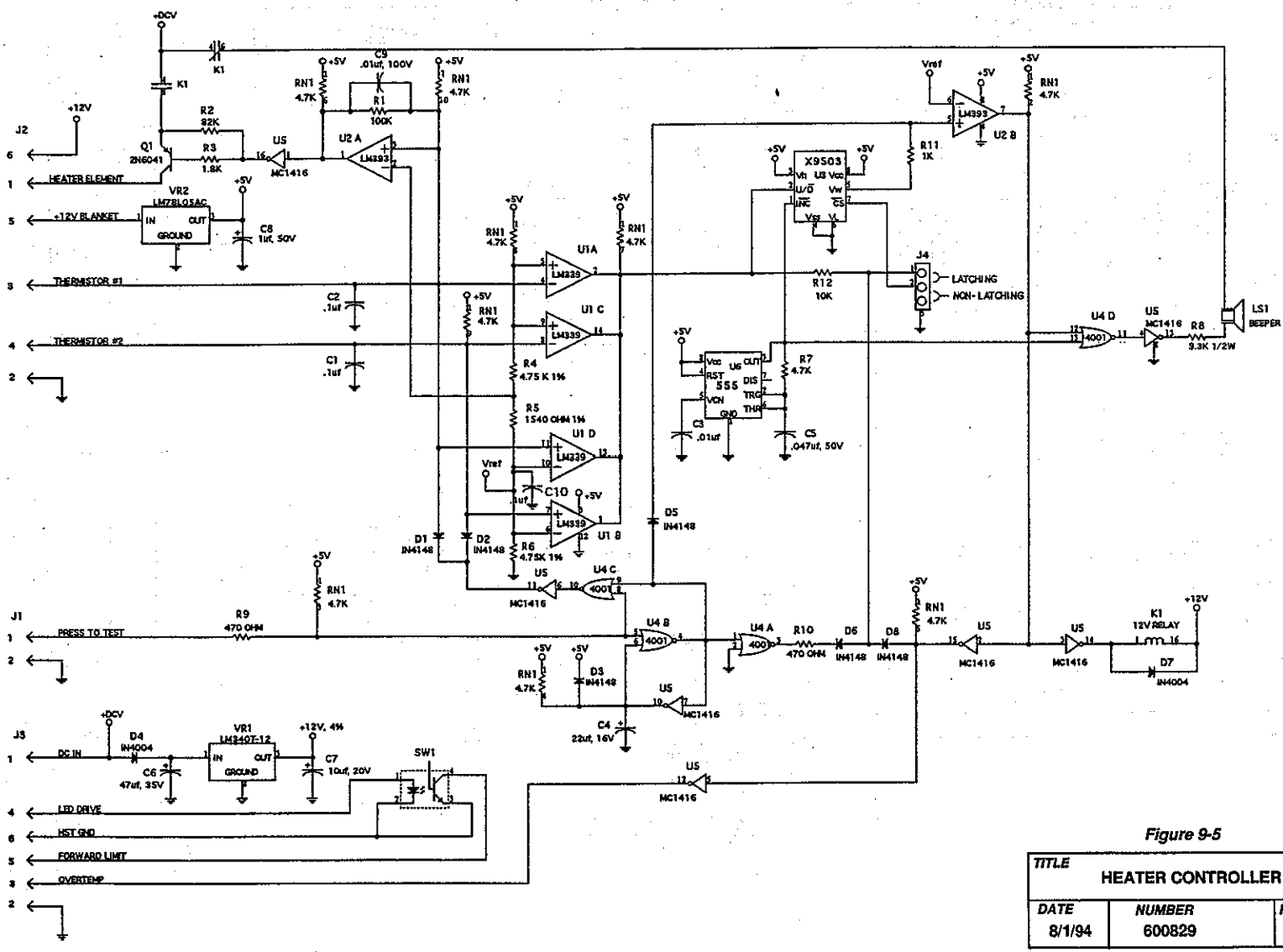


Figure 9-5

TITLE		
HEATER CONTROLLER		
DATE	NUMBER	REV
8/1/94	600829	G

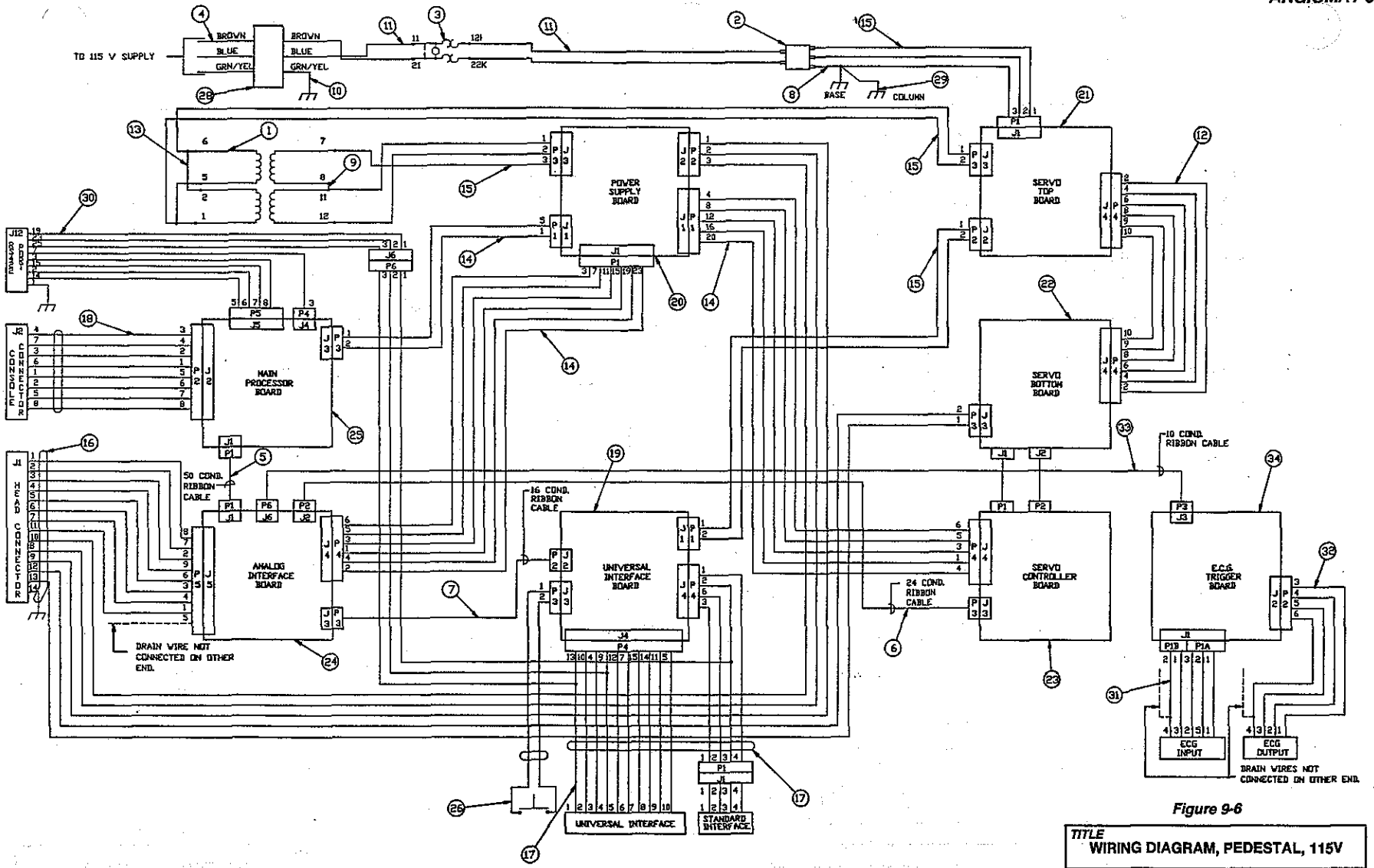


Figure 9-6

TITLE		
WIRING DIAGRAM, PEDESTAL, 115V		
DATE	*NUMBER*	*REV*
7/24/92	600941	—

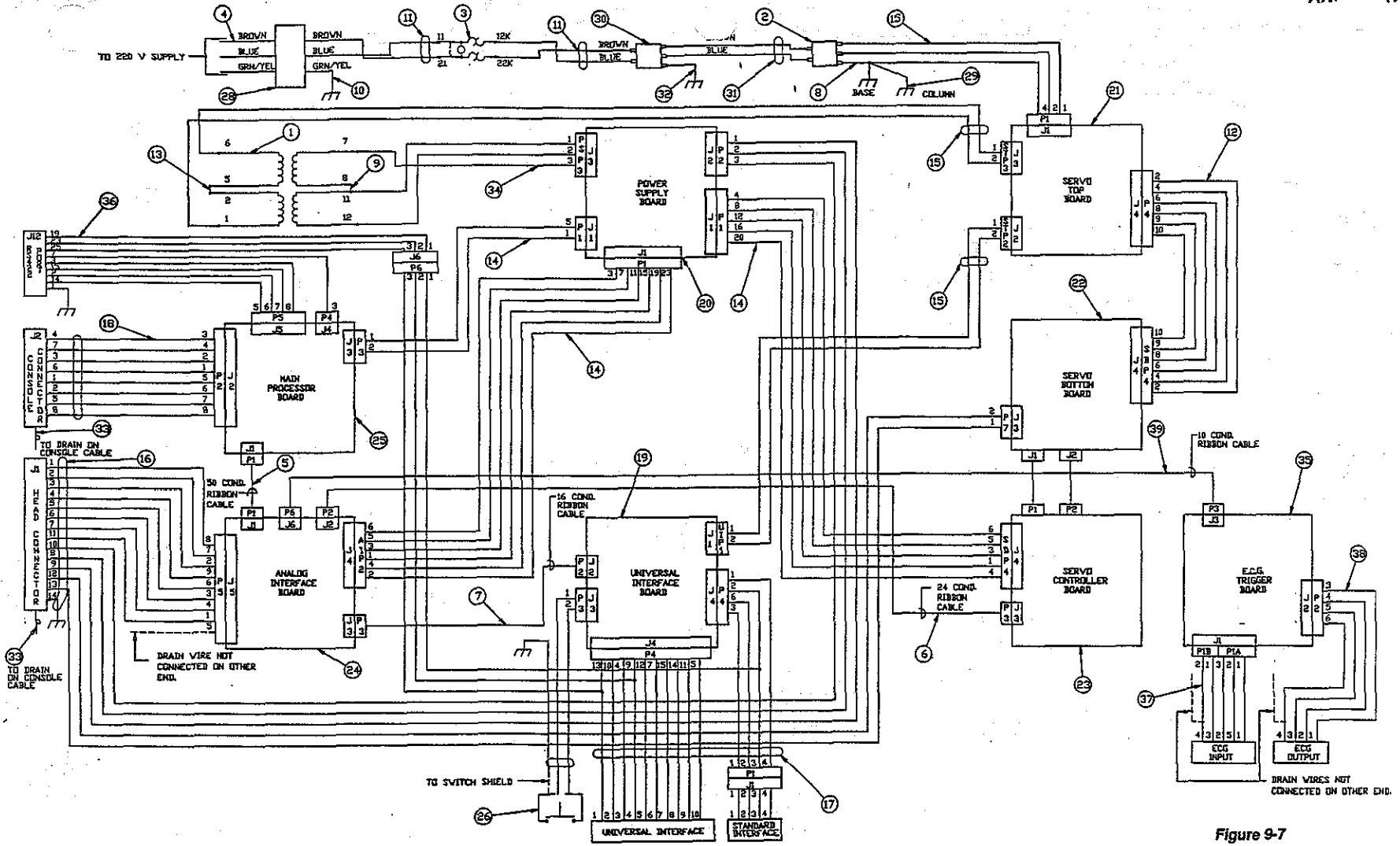


Figure 9-7

TITLE		
WIRING DIAGRAM, PEDESTAL, 220V		
DATE	NUMBER	REV
7/24/92	600939	----

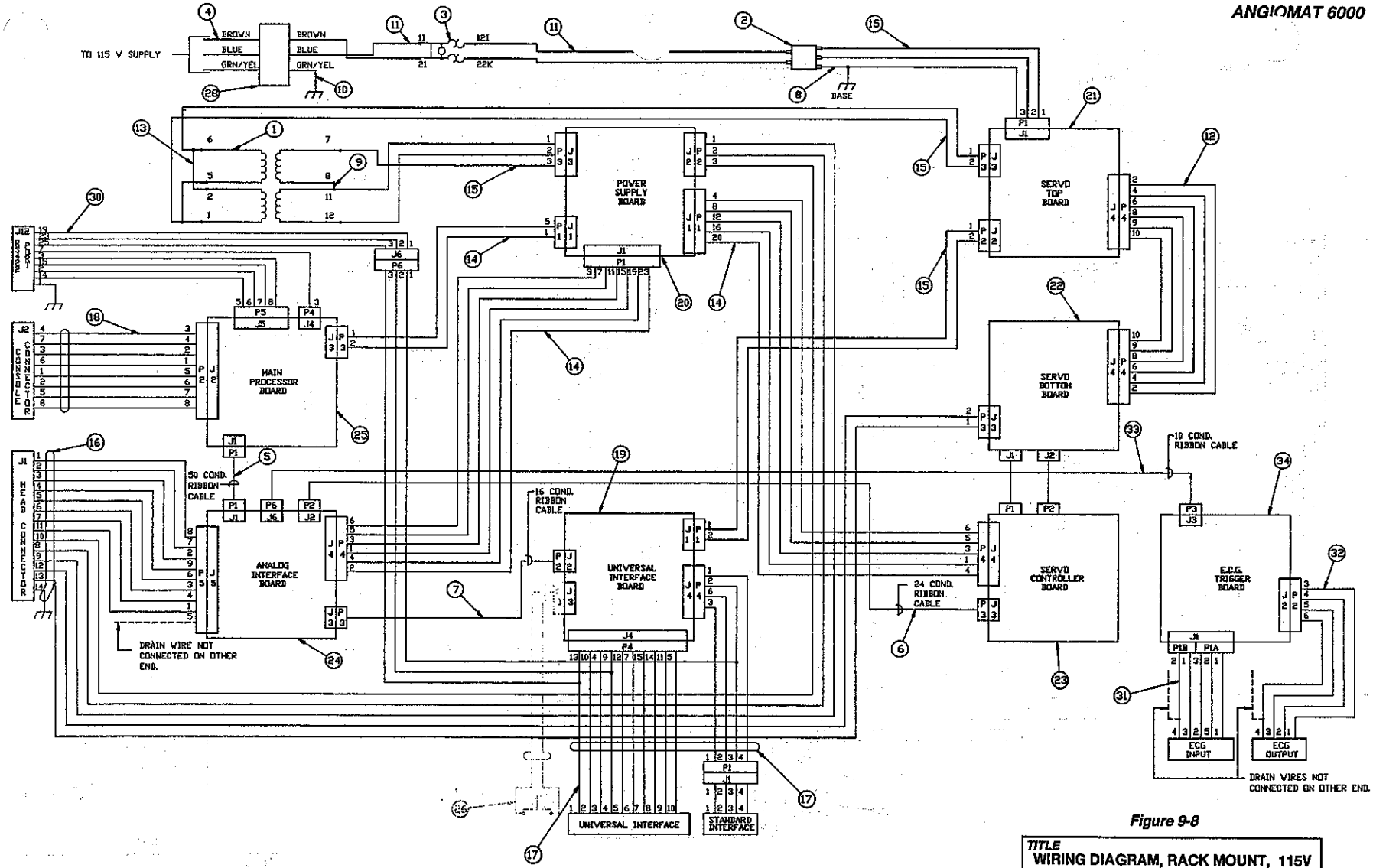


Figure 9-8

TITLE		
WIRING DIAGRAM, RACK MOUNT, 115V		
DATE	*NUMBER*	*REV*
7/24/92	600943	—

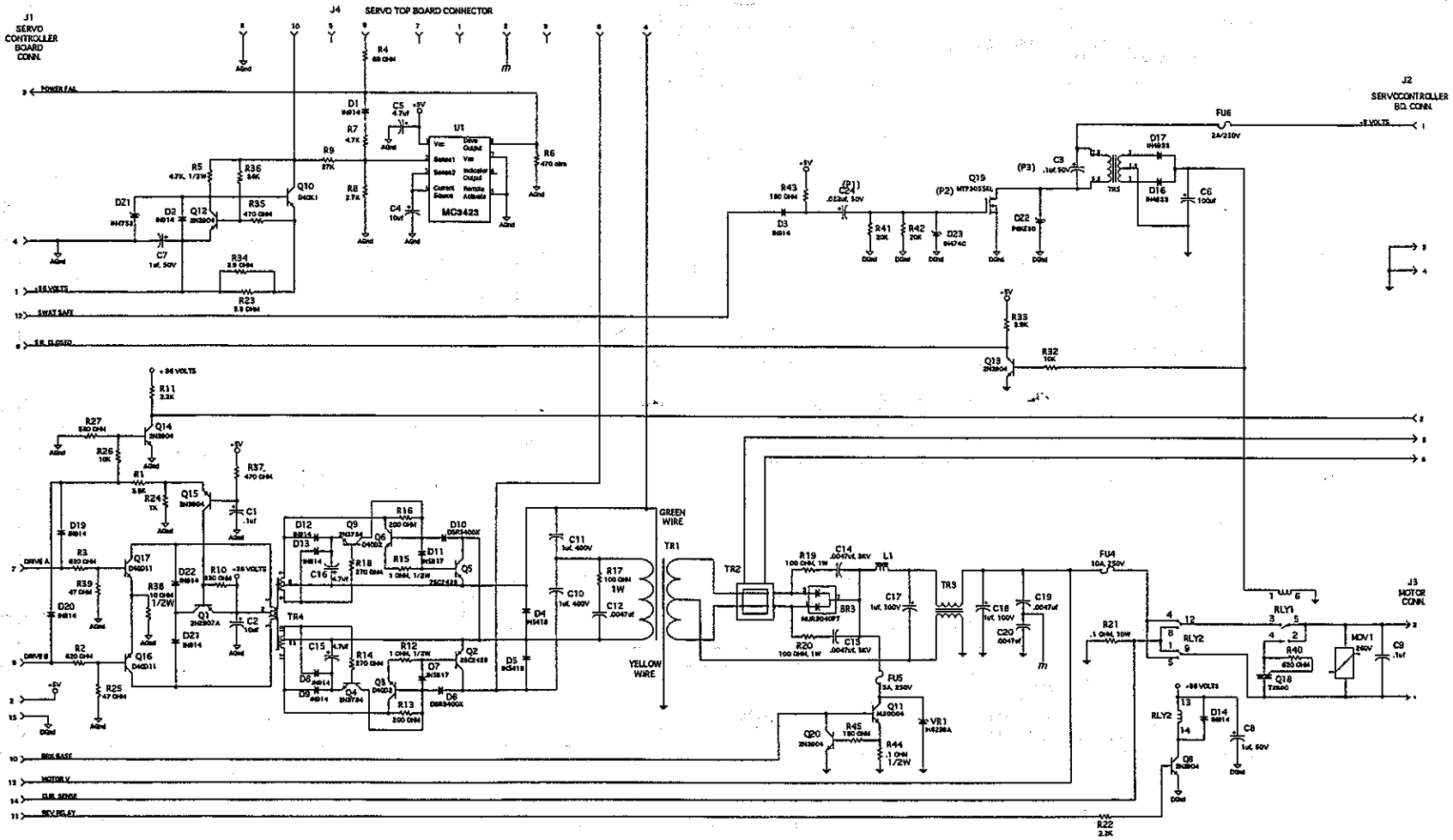


Figure 9-9

TITLE		
SERVO BOTTOM		
DATE	*NUMBER*	*REV*
10/20/94	600803	P

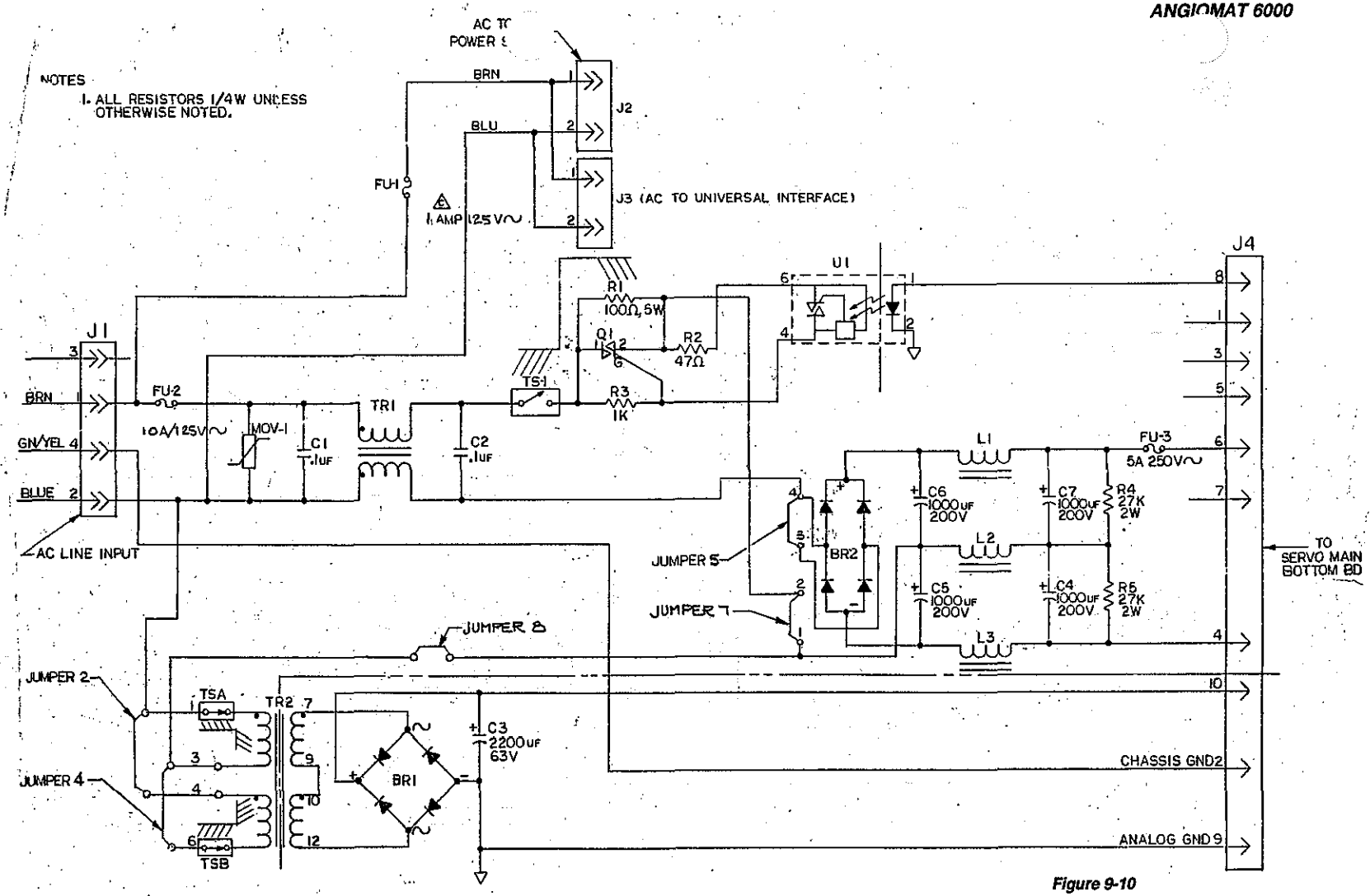


Figure 9-10

TITLE		
SERVO TOP, 115V		
DATE	NUMBER	REV
7/12/91	600502	J

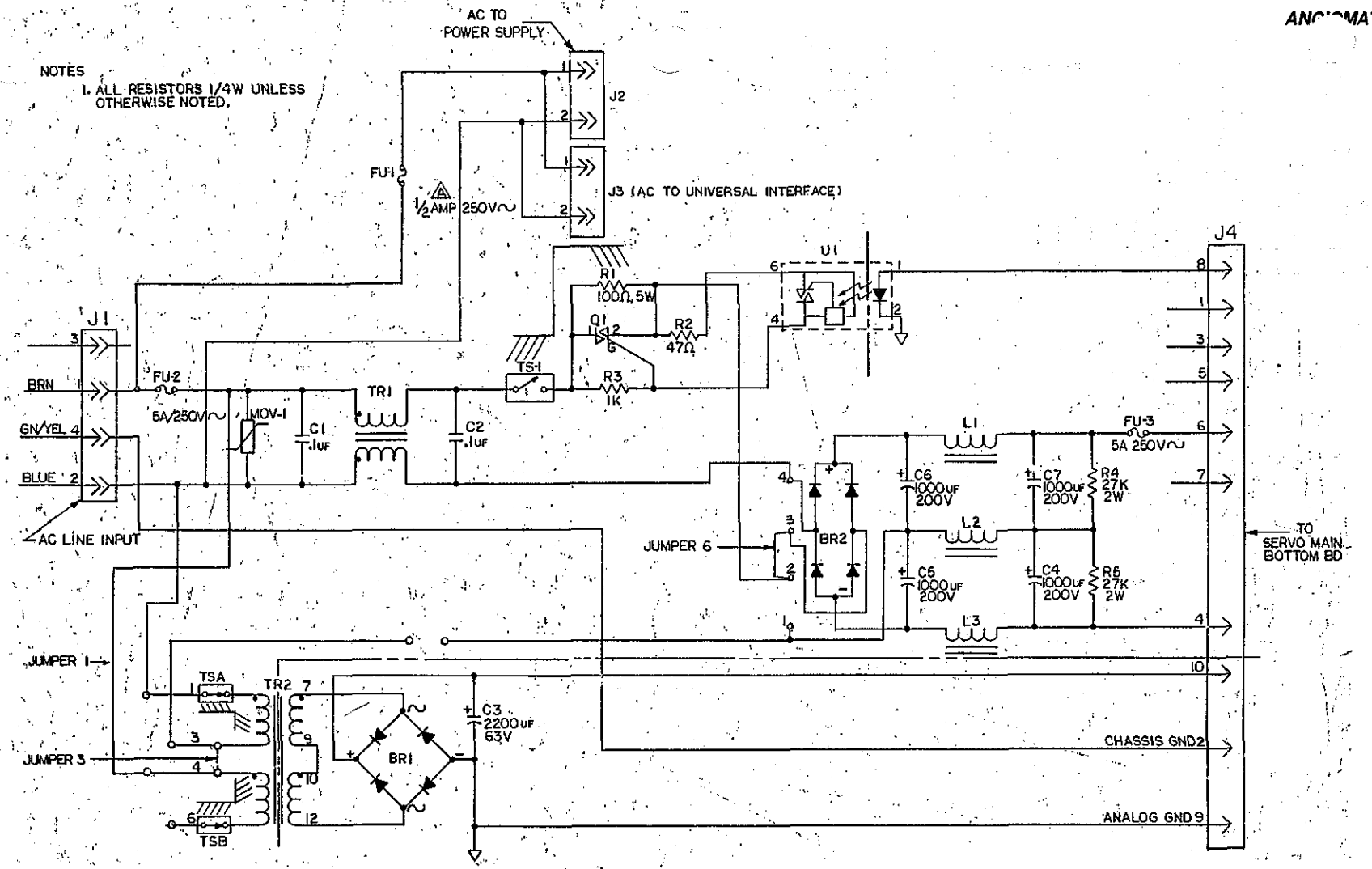


Figure 9-11

TITLE		
SERVO TOP, 220V		
DATE	NUMBER	REV
7/12/91	600473	J

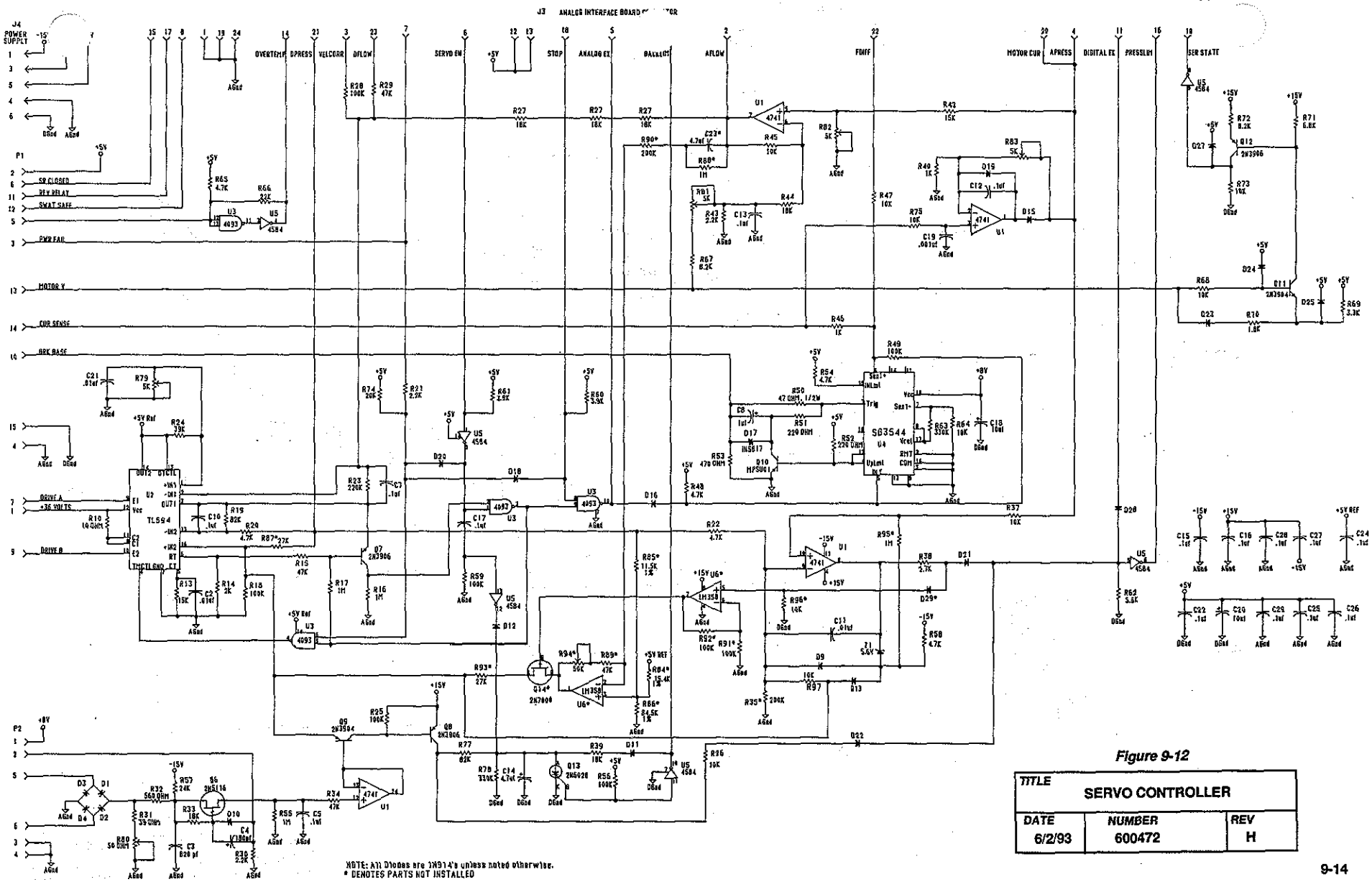
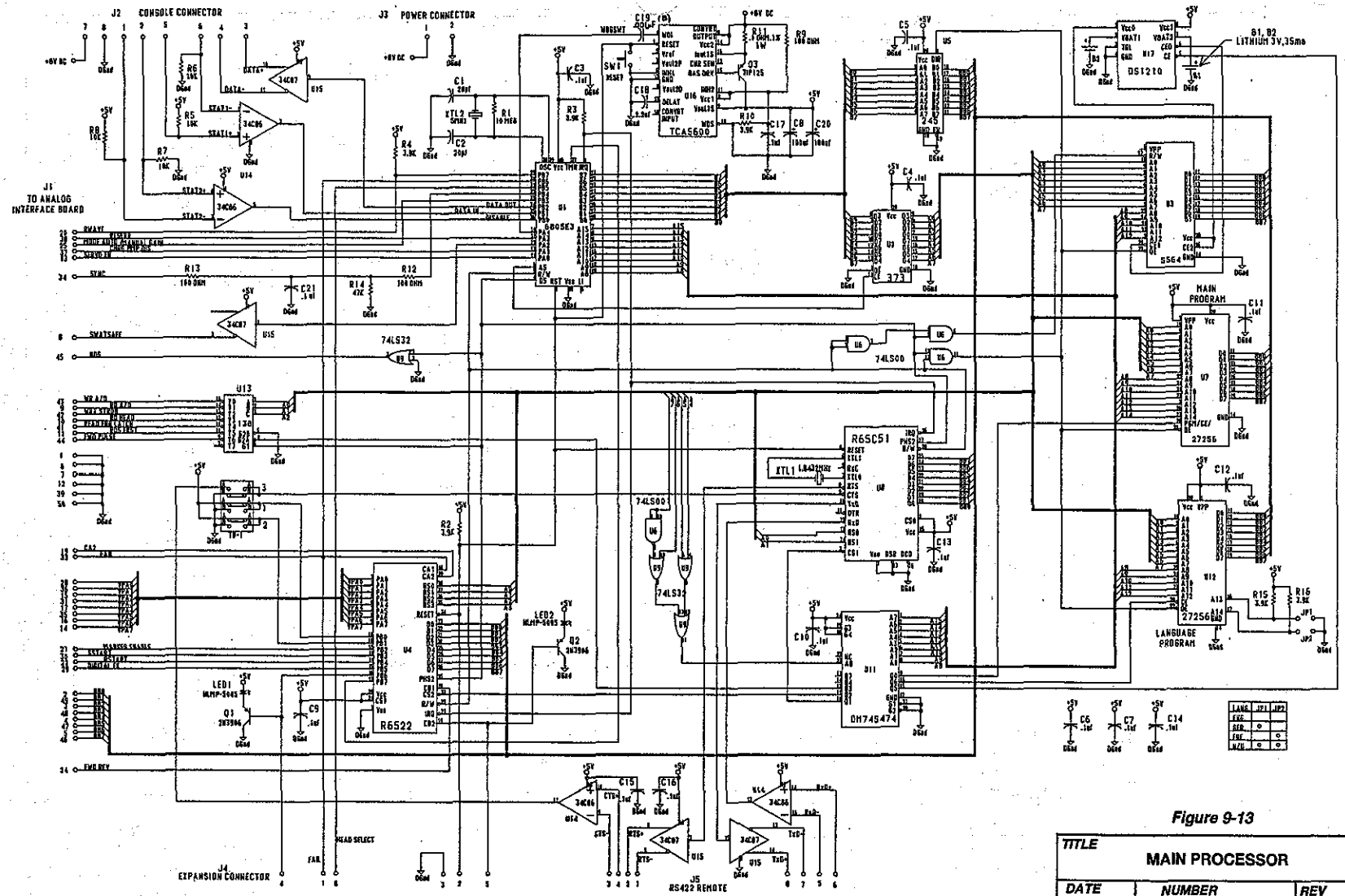


Figure 9-12

TITLE		
SERVO CONTROLLER		
DATE	NUMBER	REV
6/2/93	600472	H


J2 CONSOLE CONNECTOR
J3 POWER CONNECTOR
J1 TO ANALOG INTERFACE BOARD
J4 EXPANSION CONNECTOR
J5 RS422 REMOTE
B1, B2 LITHIUM 3V,35ma
MAIN PROGRAM
LANGUAGE PROGRAM
R6522
R6501
R6502
R6503
R6504
R6505
R6506
R6507
R6508
R6509
R6510
R6511
R6512
R6513
R6514
R6515
R6516
R6517
R6518
R6519
R6520
R6521
R6522
R6523
R6524
R6525
R6526
R6527
R6528
R6529
R6530
R6531
R6532
R6533
R6534
R6535
R6536
R6537
R6538
R6539
R6540

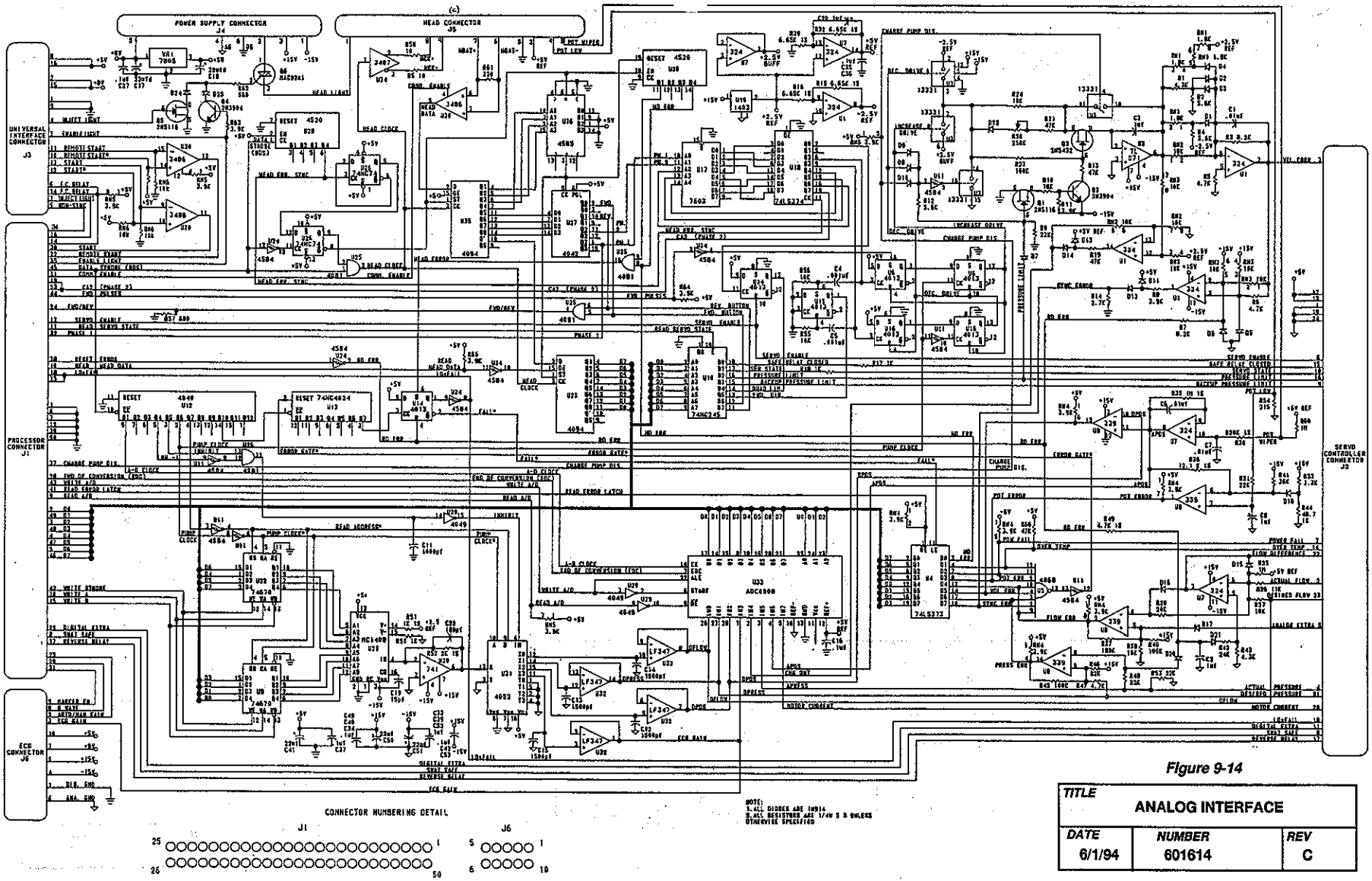


Figure 9-14

TITLE		
ANALOG INTERFACE		
DATE	NUMBER	REV
6/1/94	601614	C

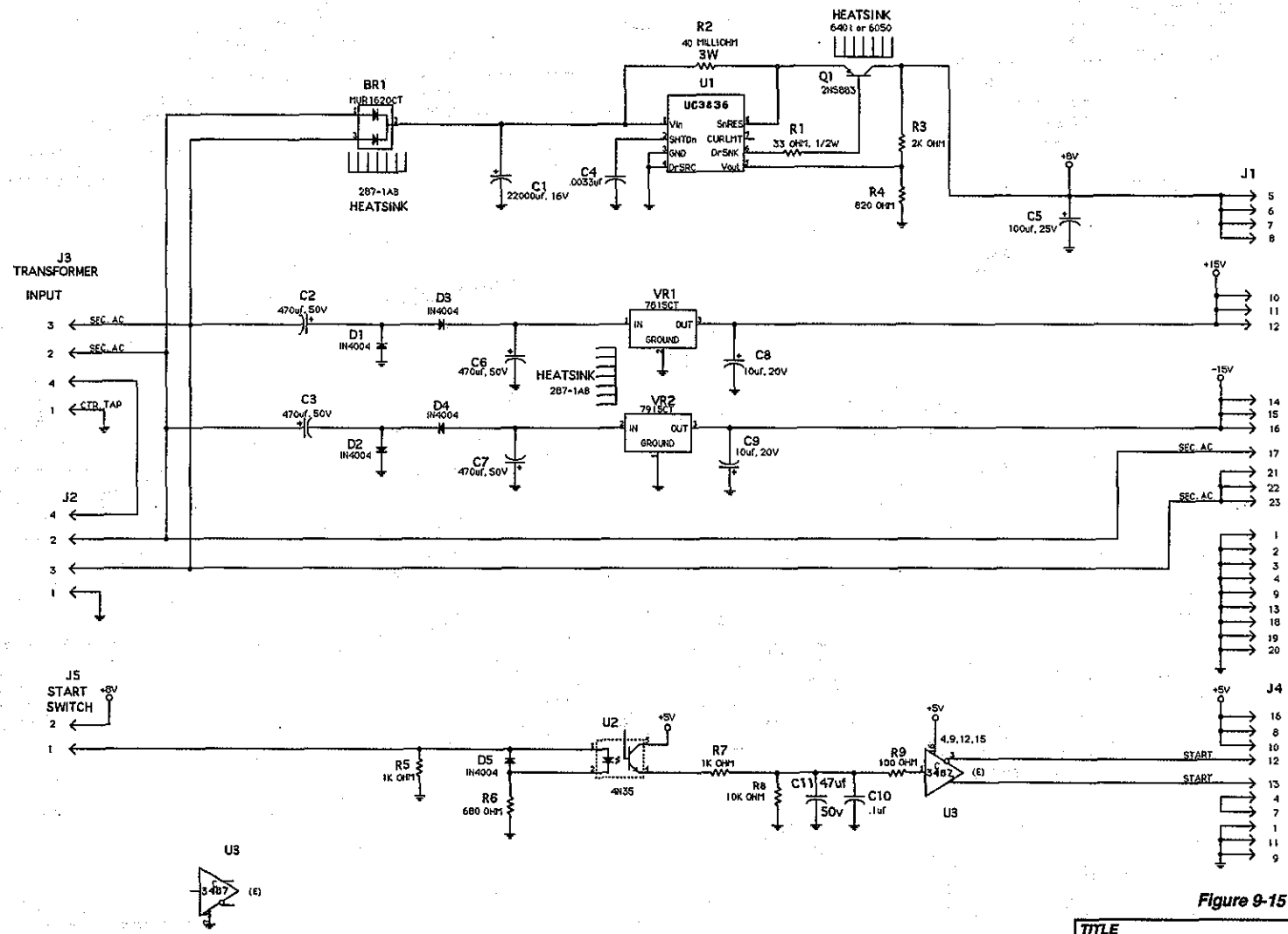


Figure 9-15

TITLE		
POWER SUPPLY		
DATE	NUMBER	REV
11/15/94	600487	E

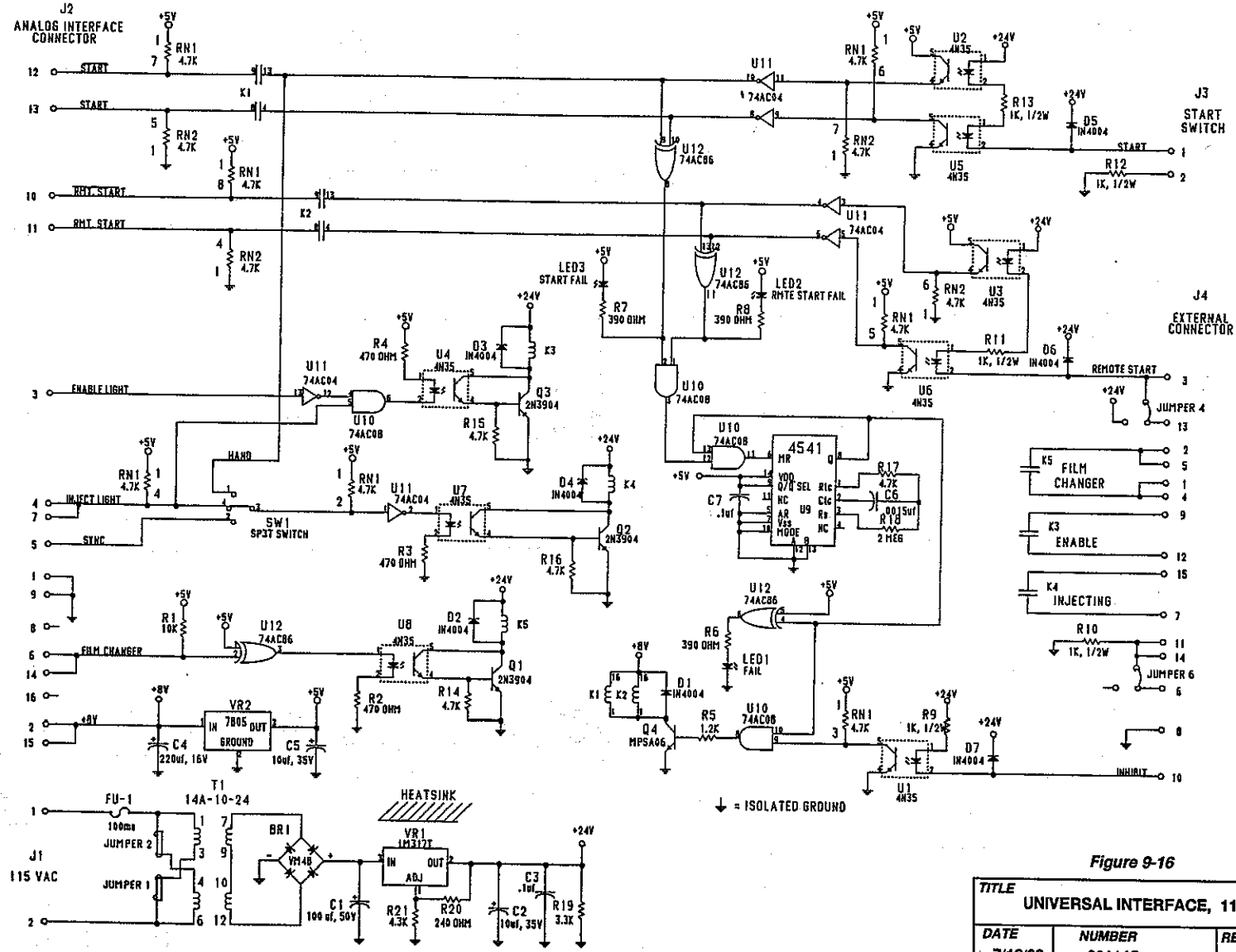


Figure 9-16

TITLE		
UNIVERSAL INTERFACE, 115V		
DATE	NUMBER	REV
7/13/92	601115	C

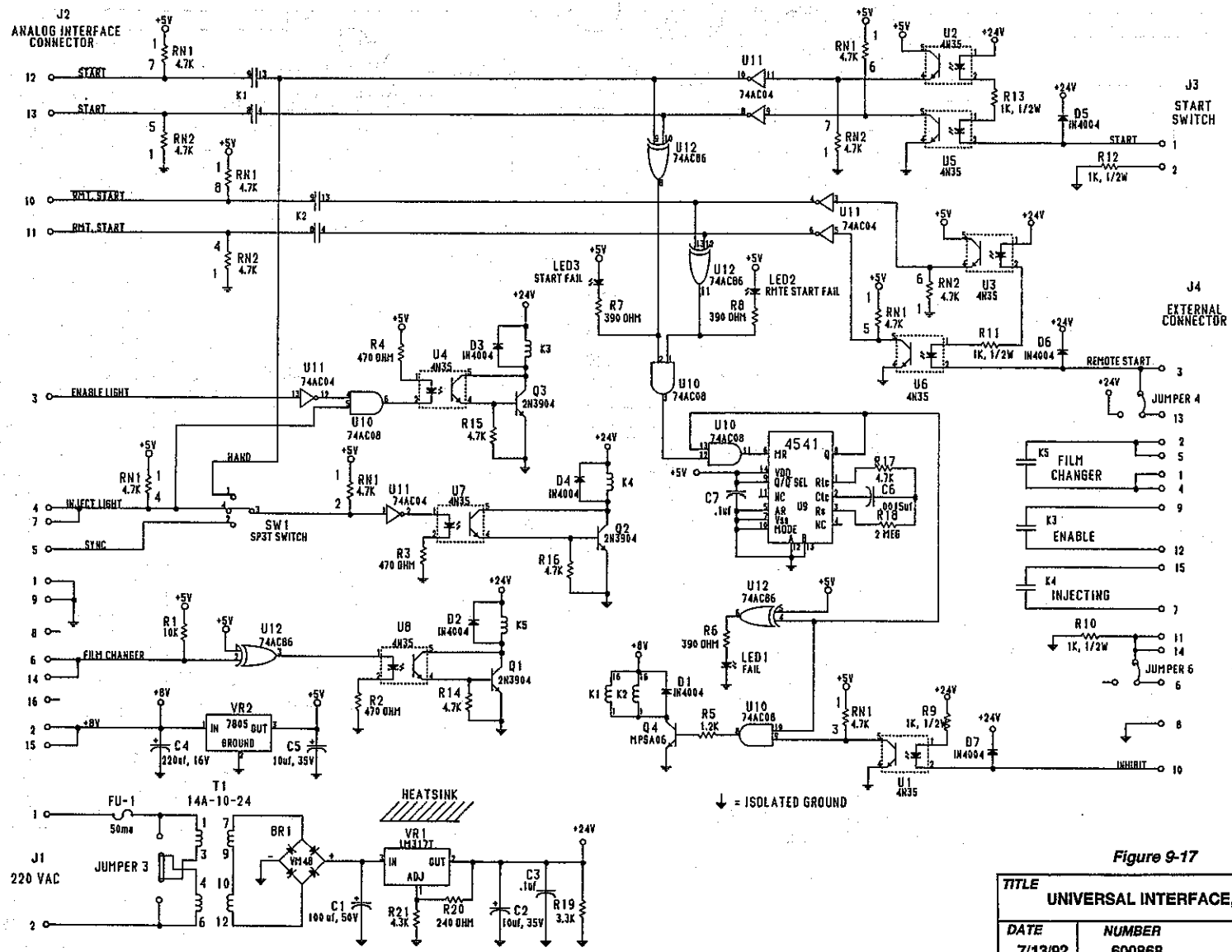


Figure 9-17

TITLE		
UNIVERSAL INTERFACE, 220V		
DATE	NUMBER	REV
7/13/92	600868	F

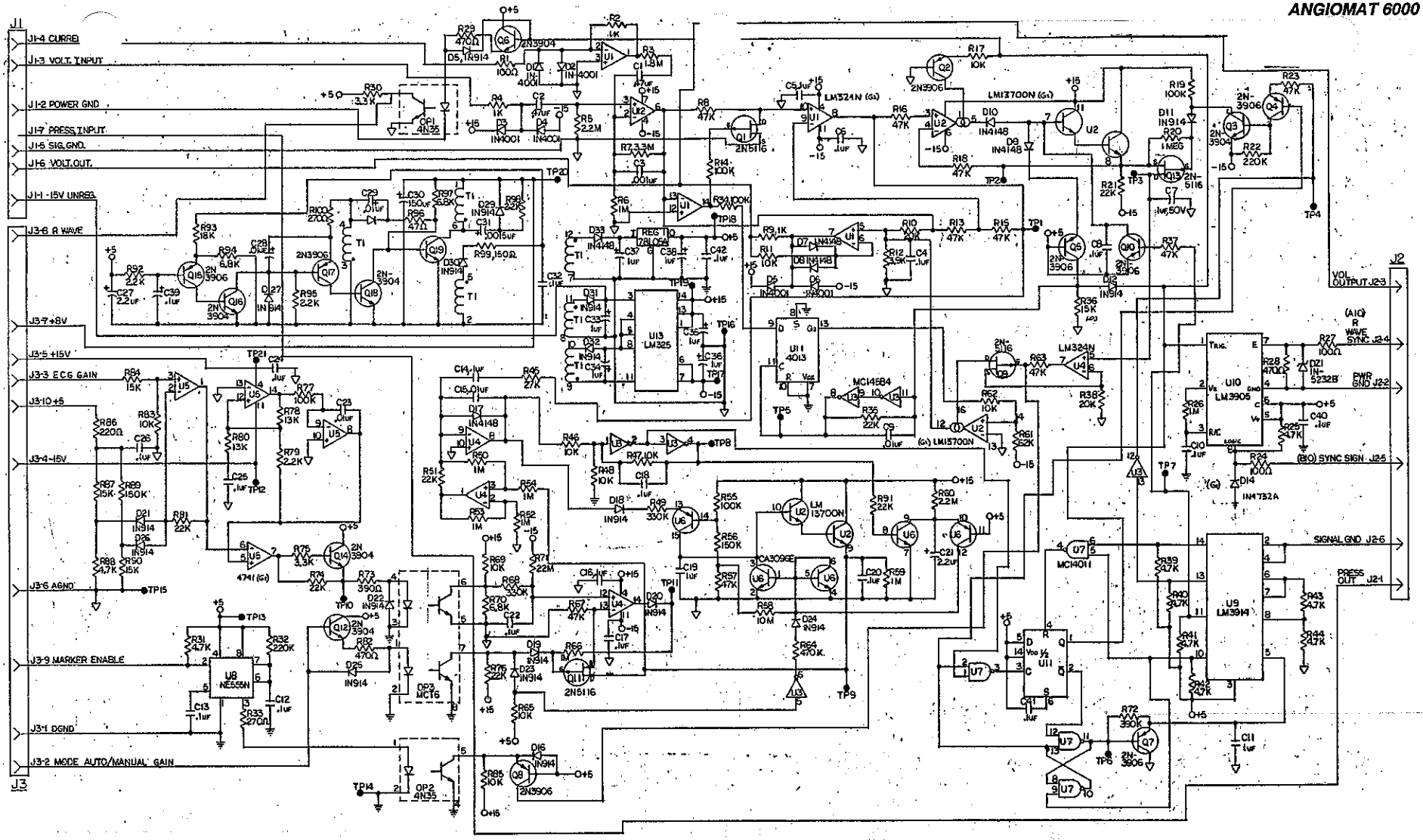

J1
J1-4 CURRD
J1-3 VOLT. INPUT
J1-2 POWER GND
J1-7 PRESS. INPUT
J1-5 SIG. GND.
J1-6 VOLT. OUT.
J1-1 -15V UNREG.
J3-6 R WAVE
J3-7 +8V
J3-5 +15V
J3-3 ECG GAIN
J3-10 +5
J3-4 -15V
J3-8 AGND
J3-9 MARKER ENABLE
J3-1 DGND
J3-2 MODE AUTO/MANUAL GAIN
J3
J2
VOL. OUTPUT J2-3
(A10) R WAVE SYNC J2-4
PWR GND J2-2
(B10) SYNC SIGN. J2-5
SIGNAL GND J2-6
PRESS. OUT J2-1
LM324N (G1)
LM13700N (G1)
MC14584
4013
4741 (G1)
NE555N
CA3096E
MC14011
LM3914
LM3905
OP1 4N35
OP2 4N35
OP3 MCT6
2N3906
2N3904
2N5116
IN914
IN4148
IN4001
IN4732A
TITLE
ECG TRIGGER
DATE
11/30/93
NUMBER
600482
REV
G

Figure 9-18

Angiomat 6000
Preventative Maintenance Checklist

Base/Elect Cab S/N | | | | | | | | |

Powerhead S/N | | | | | | | | |

Console S/N | | | | | | | | |

Model Number | | | | | | | | |

Customer _____

This Checklist is to be used in conjunction with Chapter 7 of the Installation and Service Manual.

POWERHEAD

VISUAL INSPECTION

- ❑ **1.** Reverse syringe plunger.
- ❑ **2.** Inspect the pressure jacket.
- ❑ **3.** Inspect the ram, seals and heater connector.
- ❑ **4.** Check the syringe clip for proper operation.
- ❑ **5.** Check the heater and its cable.
- ❑ **6.** Check the powerhead connector.
- ❑ **7.** Check the powerhead cable.

OPERATIONAL CHECK

- ❑ **1.** Check the powerhead arm and pivot movement.
- ❑ **2.** Check operation of the powerhead keys.
- ❑ **3.** Check operation of the Heater Test key.
- ❑ **4.** Check the ram.
- ❑ **5.** Check operation of the pressure jacket plate, knob and latches.
- ❑ **6.** Check the syringe size LED indicators.
- ❑ **7.** Check the "Injecting" and "Enabled" lights.

KEYBOARD CONSOLE

VISUAL INSPECTION

- ❑ **1.** Check the keyboard console cable.
- ❑ **2.** Check the keyboard console connector.
- ❑ **3.** Check the assembly for damage.

OPERATIONAL CHECK

- ❑ **1.** Check all pixels and LED's for proper operation.
- ❑ **2.** Check operation of the Start key and Remote Start switch.
- ❑ **3.** Check all displayed characters for clear operation.
- ❑ **4.** Check the Preferred Injection feature.
- ❑ **5.** Check the operation of the Save/Enter Name key.
- ❑ **6.** Check the operation of the Delete key.
- ❑ **7.** Check that the "Required Fill Sequence" message appears when needed.
- ❑ **8.** Check the operation of the Units key.
- ❑ **9.** Enable and run a mock injection for Multiple Deliveries.
- ❑ **10.** Enable and run a Multiphasic Injection.
- ❑ **11.** Check the operation of the New Patient key.
- ❑ **12.** Check the ECG function.

PED. BASE/ELECT. CABINET

VISUAL INSPECTION

- ❑ **1.** Check the power cord.
- ❑ **2.** Check the start cord.
- ❑ **3.** Check optional and external cables.
- ❑ **4.** Check all connectors.
- ❑ **5.** Check that the hub and handle bar are secure.
- ❑ **6.** Check that the cover is secure.
- ❑ **7.** Check casters for ease of movement.

ELECTRICAL CHECKS

LEAKAGE AND GROUND IMPEDANCE

- ❑ **1.** Check the electrical leakage.
- ❑ **2.** Disconnect the leakage test equipment.
- ❑ **3.** Check the ground impedance.

POWER SUPPLIES

- ❑ **1.** Access the Analog Interface Board and Servo Controller Board.
- ❑ **2.** Check the following voltage supplies:
  - ❑ • Check Ground. Result _____
  - ❑ • Check + 5 volt supply. Result ____
  - ❑ • Check + 8.5 volt supply. Result __
  - ❑ • Check + 15 volt supply. Result ____
  - ❑ • Check - 15 volt supply. Result ____
  - ❑ • Check + 36 volt supply. Result ____

CALIBRATION CHECKS

ADJUSTMENTS

- ❑ **1.** Check the Quadrature Adjustment.
- ❑ **2.** Check the "Required Fill Sequence".
- ❑ **3.** Check the Head Scale postion.

CALIBRATIONS

- ❑ • Servo Offset Adjustment
- ❑ • Velocity Calibration
- ❑ • Low Speed Circuit
- ❑ • Backup Pressure Limit
- ❑ • Primary Pressure Limit

CLEANING AND LUBRICATION

- ❑ **1.** Check for spilled contrast medium.
- ❑ **2.** Lightly lubricate the latches and knob mechanism.
- ❑ **3.** Carefully lubricate the arm.
- ❑ **4.** Lightly lubricate the four casters.

CUSTOMER INTERFACE

- ❑ Answer all customer questions regarding operation or use of the equipment. Discuss any areas of concern the customer may have about the unit.

COMMENTS

_____
_____
_____
_____
_____
_____
_____
_____
_____

_____
Customer Signature **Date**

_____
Customer (print name)

_____
Service Representative **Date**

_____
Service Representative (print name)

Angiomat 6000 Installation and Checkout

Base/Elect Cab S/N | | | | | | | | |

Powerhead S/N | | | | | | | | |

Console S/N | | | | | | | | |

Model Number | | | | | | | | |

Customer _____

This Checklist is to be used in conjunction with Chapter 2 and Chapter 3 of the Installation and Service Manual.

Refer to Chap. 3 of the Install. and Service Manual.

MOUNTING CONFIGURATION

- ❑ Standard Pedestal-mounted console and powerhead. Types of cables used:
  _____
  _____
- ❑ Pedestal-mounted console with remote powerhead. Types of cables used:
  _____
  _____
- ❑ Remote console and powerhead with Rack or Table-mounted Electronics Cabinet. Types of cables used:
  _____
  _____
- ❑ Other
  Types of cables used:
  _____
  _____

VOLTAGE

- ❑ 105-125 VAC
- ❑ 210-240 VAC

LANGUAGE

- ❑ English
- ❑ German
- ❑ French

REMOTE START CONTROLS

- ❑ _____

ECG TRIGGER OPTION WIRING

- ❑ _____

IMAGING SYSTEM

- ❑ System used _____
- ❑ Cables used _____

Refer to Chap. 3 of the Install. and Service Manual.

POWER-UP CHECK

- ❑ **1.** Prepare the Injector.
- ❑ **2.** Check the Injector's initial response.
- ❑ **3.** Check the operation of the LEDs and lights.

POWERHEAD CHECK

- ❑ **1.** Check the indicators
- ❑ **2.** Check for smooth motion.
- ❑ **3.** Check the loading speed

FUNCTIONAL CHECKS

- ❑ **1.** Press Select key under X-ray Delay.
- ❑ **2.** Press Select key under Injection Duration.
- ❑ **3.** Press Select key under Achieved Flow.
- ❑ **4.** Press Select key under Achieved Volume.
- ❑ **5.** Press Select key under Achieved Pressure.
- ❑ **6.** Press the Enable key.
- ❑ **7.** Press the 9 key.
- ❑ **8.** Press the Yes key.
- ❑ **9.** Press and hold the Start switch.
- ❑ **10.** At the end of the injection, look for the required responses.
- ❑ **11.** Press the Reverse key and Fast button to fully retract the plunger.
- ❑ **12.** Repeat the injection tests with the Programmed Flow and Volume shown in the chart.
- ❑ **13.** Program, enable and start the required injection. Press the disable key.
- ❑ **14.** Press the Remote switch to ensure that the switch is not sticking opened or closed at any time.

ML/M CHECK

- ❑ **1.** Press the reverse key to fully retract the plunger.
- ❑ **2.** Press the Select key under Achieved Flow. The LED next to Programmed Flow should light. Press the Units key so ml/M appears in the System Display. Set the Programmed Flow at 40 ml/M.
- ❑ **3.** Set the Programmed Volume at 20 ml.
- ❑ **4.** Press Enable, press 9 to override fill sequence if necessary, then press Yes in response to messages from the System Display.
- ❑ **5.** Press the Yes key and the Start key (on the control panel) at the same time, then release. The injector will latch and continue running.
- ❑ **6.** At the end of the injection, the System Display should show the listed values.

ML/H CHECK

- ❑ **1.** Press the Reverse key and Fast button to fully retract the plunger.
- ❑ **2.** Press the Select key under Achieved Flow. The LED next to Programmed Flow should light. Press the Units key so ml/H appears in the System Display. Set the Programmed Flow at 40 ml/H.
- ❑ **3.** Set the Programmed Volume at 4 ml.
- ❑ **4.** Press Enable, press 9 to override fill sequence if necessary, then press Yes in response to messages from the System Display.
- ❑ **5.** Press the Yes key and the Start key at the same time or press the Start Switch.
- ❑ **6.** At the end of the injection, the System Display should show the listed values.

TIMER CHECK (INJECTION DELAY)

- ❑ **1.** Press the Reverse key and Fast button to fully retract the plunger.
- ❑ **2.** Press the Select key under Achieved Flow. The LED next to Programmed Flow should light. Press the Units key so ml/S appears in the System Display. Set the Programmed Flow at 6 ml/S.
- ❑ **3.** Set the Programmed Volume at 90 ml.
- ❑ **4.** Press the Select key under Inject Delay so the LED next to Inject Delay lights. Set a delay of 15 seconds.
- ❑ **5.** Press Enable, press 9 to override fill sequence if necessary, then press Yes in response to messages from the System Display.
- ❑ **6.** Press and hold the start switch while simultaneously starting a stop watch. The injection should start 14-16 seconds later.

TIMER CHECK (X-RAY DELAY)

- ❑ **1.** Press the Select key under X-Ray Delay once so the LED next to X-ray Delay lights. Set a delay of 15 seconds.
- ❑ **2.** Remove the cover from the base/ electronics cabinet. (see Chapter 7)
- ❑ **3.** Connect an ohmmeter to pins 10 and 3 of the Universal Interface board (located inside the base). This connection should read infinity (open circuit). Keep this connection for the next step.
- ❑ **4.** Press Enable, press 9 to override fill sequence, then press Yes in response to messages from the System Display.
- ❑ **5.** Press the start switch. The connection should continue to read infinity for 14-16 seconds, then it should read 0 ohms (closed circuit) until the start switch is released. (The change should coincide with the end of the injection.)

TRANSITION TIME CHECK

- ❑ **1.** Press the Reverse key and Fast button to fully retract the plunger.
- ❑ **2.** Press the Select key under Injection Duration twice so the LED next to Transition Time lights. Set the Transition Time at 6 seconds.
- ❑ **3.** Set the Programmed Flow at 20 ml/S.
- ❑ **4.** Set the Programmed Volume at 100 ml.
- ❑ **5.** Press Enable, press 9 to override Achieved Volume 0.5-1.5 ml fill sequence as necessary, then press Yes in response to messages from the System Display.
- ❑ **6.** Press the start switch. The plunger should accelerate for 6 seconds, then continue at a steady rate for 2 more seconds.
- ❑ **7.** At the end of the injection, the System Display should show the listed values.
- ❑ **8.** Change the Transition time to 0.

INJECTION DURATION CHECK

- ❑ **1.** Press the reverse key to fully retract the plunger.
- ❑ **2.** Set the Programmed Flow at 1. (The flow scale should show ml/S.)
- ❑ **3.** Set the Injection Duration at 1 S. Toggle once or twice as necessary.
- ❑ **4.** Press Enable, press 9 to override fill sequence if necessary, then press Yes in response to messages from the System Display. Programmed volume will show 1 ml.
- ❑ **5.** Press the start switch. At the end of the injection, the System Display should show the listed values.
- ❑ **6.** Press the reverse key to fully retract the plunger.
- ❑ **7.** Repeat this check, changing only the Injection Duration, as shown in the chart. After each injection, compare the results shown in the System Display with the expected values shown in the chart.

PRESSURE LIMIT ACTIVATION TEST

- ❑ **1.** Install and fill the syringe with water. Attach L-F Pressure Test Fixture, P/N 600867, to the syringe.
- ❑ **2.** Open valve on gauge assembly.
- ❑ **3.** Set parameters to deliver an injection at 20 ml/s, 120 ml volume, 1000 psi.
- ❑ **4.** While delivering injection, slowly close valve until a pressure of 750 psi is indicated on the gauge.
- ❑ **5.** Run the second half of the syringe at the 750 psi indication. At the end of the injection, the achieved pressure readout in the system display should read approximately 750 psi *and* the Pressure Limit LED on the control console should not be lit.
- ❑ **6.** If the injector performs as indicated in Step 4, repeat Steps 3 and 4 at a pressure gauge reading of 1000 psi. At the end of this injection, the achieved pressure readout in the system display should read 1000 psi and the Pressure Limit LED should be lit.

PRE-PROGRAMMED INJECTION CHECKS

- ❑ **1.** Turn unit off. Wait several seconds, then turn on power to the Angiomat. After the Power Up and Self Test, Test #1 should appear in the display.
- ❑ **2.** Press the Reverse key and the Fast button to fully retract the plunger.
- ❑ **3.** Press Enable, press 9 to override fill sequence if necessary, then press Yes in response to messages from the system display.
- ❑ **4.** Press and hold the remote start switch. At the end of the injection, release the remote start switch. The system display should show the listed values.

FINAL CHECKS

- ❑ Installation Completed
- ❑ Unit is operating Properly

COMMENTS

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Customer Signature **Date**

Customer (print name)

Service Representative **Date**

Service Representative (print name)